TECHNICAL MEETING AND DEDICATION OF THE TIMBER AND WATERSHED LABORATORY

August 27-29, 1964

Blackwater Falls Lodge and

Parsons, West Virginia

United States Department of Agriculture
Forest Service
Northeastern Forest Experiment Station
Upper Darby, Pennsylvania

ATTENDANCE

Forest Service:

Washington, D. C.:

Vernon O. Hamre, Thomas C. Nelson, Clark Holscher, Edward G. Grest, Mason B. Bruce, Alve L. Richey, and Edward P. Cliff.

Region 7:

Richard F. Droege, Harold C. Nygren, Sigurd J. Dolgaard, Gilbert L. Varney, Glenn E. Smith, Frank J. Paradise, Richard D. Jones, A. H. Anderson, John R. Hicks, William Curnutt, James S. Sabin, Jr., Alan R. Duhnkrack, Ephe M. Olliver, Harry B. Mahoney, Arnold F. Schultz, and William W. Wentz.

Northeastern Station:

Ralph W. Marquis, Warren T. Doolittle, Howard W. Lull, Ted J. Grisez, William B. Leak, Kenneth G. Reinhart, George R. Trimble, Jr., and Irvin C. Reigner.

Central States Station:

Benjamin A. Roach and Edward A. Johnson

Lake States Station:

Sidney Weitzman

Southeastern Station:

Thomas F. McLintock and Paul C. Guilkey

Region 8:

Peter J. Hanlon and Quentin R. Boerner

Region 9:

Howard S. Cook and W. A. Wertz

State Foresters or Directors:

Maryland--H. C. Buckingham
Pennsylvania--Ralph W. Wible
Virginia--Caleb M. Pennock, Jr.

West Virginia--Lester D. McClung

State Extension Foresters:

Maryland--Harry W. Dengler
Pennsylvania--Edward P. Farrand
West Virginia--Howard P. Berthy

Schools:

Pennsylvania State University--Dr. Peter W. Fletcher and
Dr. William E. Sopper
Virginia--Dr. John F. Hosner
West Virginia--Dr. Earl H. Tryon

Others:

Consulting Forester--John F. Tillinghast
Soil Conservation Service--Thomas B. Evans and
Ross H. Mellinger
Interstate Commission on the Potomac River Basin--Carl J. Johnson
Monongahela Power Company--Walter C. Gumbel
West Virginia Pulp and Paper--H. E. Matics

PROGRAM

Thursday, August 27--9:00 A.M.

Forest Land Management in Appalachia

Chairman:	Walter C. Gumbel, Monongahela Power Company
Opening Remarks:	Edward P. Cliff, Chief Forest Service Washington, D. C.
	Ralph W. Marquis Northeastern Forest Experiment Station Forest Service
Management Problems:	
National Forests:	Harold C. Nygren, Region 7, Forest Service
State Forests:	Ralph W. Wible Pennsylvania Dept. of Forests and Waters
Private Lands:	Harold E. Matics West Virginia Pulp and Paper
Discussion:	
What Management Needs from Research	
Timber Management:	Glenn Smith, Region 7, Forest Service
Watershed Management:	Gilbert L. Varney, Region 7, Forest Service
Discussion:	

Thursday, August 27--1:30 P.M.

Forestry Research in Appalachia--Past and Present

Chairman:	Peter W. Fletcher, Pennsylvania State University

Timber Management Research Panel:

Paul C. Guilkey, Southeastern Forest Experiment Station, Forest Service

Earl H. Tryon, West Virginia University

Benjamin A. Roach, Central States Forest Experiment Station, Forest Service

George R. Trimble, Jr., Northeastern Forest Experiment Station, Forest Service

Discussion:

Watershed Management Research Panel:

Edward A. Johnson, Central States Forest Experiment Station, Forest Service

Irving C. Reigner, Northeastern (for Southeastern) Forest Experiment Station, Forest Service

William E. Sopper, Pennsylvania State University

Kenneth G. Reinhart, Northeastern Forest Experiment Station, Forest Service

Discussion:

Friday, August 28--8:30 A.M.

Forestry Research--The Future

Chairman: Thomas F. McLintock
Southeastern Forest Experiment Station, Forest Service

Programs at Parsons

Watershed Management: Howard W. Lull
Northeastern Forest Experiment Station, Forest Service

Timber Management: Warren T. Doolittle
Northeastern Forest Experiment Station, Forest Service

Discussion:

Communications: Between Research and Practice

Forestry Schools:	John F. Hosner, Virginia Polytechnic Institute
Extension:	Howard P. Berthy, Extension Forester, West Virginia University
Forest Land Manager:	William W. Wentz, Region 7, Forest Service
Research Responsibility:	Sidney Weitzman, Lake States Forest Experiment Station, Forest Service

Discussion:

Summary of Technical Meeting: Clark Holscher,
Forest Service

Friday, August 28--1:30 P.M.

Tour of the Fernow Experimental Forest

Saturday, August 29--10:00 A.M.

Dedication of the new Timber and Watershed Laboratory at Parsons.

PROBLEMS OF MULTIPLE USE MANAGEMENT OF THE NATIONAL FORESTS OF APPALACHIA

Harold C. Nygren
Region 7, Forest Service

When I started thinking about this subject "Problems of multiple use management of the National Forests of Appalachia" I listed four problems: the public relations job necessary to eliminate conflicts and public dissatisfaction, the lack of basic information for rational decisions in multiple use management, the need to keep abreast of changing public values, and finally the need for straight thinking regarding our responsibility as forest managers.

Multiple use requires that we be perceptive and skillful in public relations. If our forests were dedicated to a single purpose, our public relations job might be simpler. We would be aiming to please only one segment of the public. Under multiple use we want to please several segments with widely different interests. And this is sometimes difficult. Good timber management often requires clear cutting to get regeneration or to convert a hardwood stand to conifers. This conflicts with the need for open timber stands for turkey habitat. Timber management requires removing cull trees. This conflicts with the wishes of squirrel hunters for plentiful den trees. Timber harvest is also in conflict with the esthetic sense of some recreation seekers. Hikers resent forest development roads, and strip mining conflicts with all other uses. There are many other possibilities for conflict.

But along with the conflicts we have many instances where management of one resource enhances the use of another resource. There's no doubt that roads constructed to move timber have improved opportunities for hunting and other recreation in much of our forest area. Harvest cuts have helped maintain browse for deer. In other areas intensive timber management has made the forest more attractive for the recreation seeker. Writing on the Ozark rivers in the Journal of Forestry, J. M. Nichols, of the University of Missouri, says that the intensive management of the pine-oak forest has improved the Ozark Forests for recreation. Before management, the ragged oak stands on poor sites were not very pretty. With fire protection and a management objective of converting poor sites to pine by timber sales and TSI, there has been a dramatic esthetic improvement. The ragged oak stands have been replaced by pine. Similar improvement to the esthetic quality of poor sites in the Appalachians by intensive timber management is no doubt taking place.

There are other examples where management of one resource complements another, but we'll also have conflicts and multiple use management will continue to require good public relations. In the future we'll probably have even more serious conflicts between users of one resource than we have now between different resource user groups. This will be particularly true in the case of people interested in the recreation opportunities on the forests.

In a paper given at the SAF meeting in Boston, Robert C. Lucas, leader of the social and economic aspects of the forest recreation project at the Lake States Forest Experiment Station in St. Paul, said: "In most areas, clashes between recreationists affects satisfaction more than does competition with non-recreational uses." He says this is particularly true of logging. He tells of a survey made in the Superior Canoe country which showed that very few of the visitors even saw any logging and only about 30 percent of those who observed logging objected to it.

Others have noted the conflicts brought about by the growth in recreation. Ernie Swift, of the National Wildlife Federation, says: "The recreationist is rapidly over-grazing his pastures and is becoming a greater menace than logging."

The President's Outdoor Recreation Resource Committee report mentions the potential for conflict between various recreationists. This report recommends zoning to separate uses which are incompatible.

The ORRC report suggests a classification system for recreation zoning. They use six classes:

Areas for high density recreation
Natural environment areas
Unique natural areas
Primitive areas
Historical and cultural sites

The purists of forest recreation, the nature and wilderness lovers, are especially sensitive to intensive recreation development in the forests. The feeling seems to be growing that the problem of too many people and too much development is reducing the quality of forest recreation; that undeveloped space may be the greatest shortage for quality recreation in the future.

Testifying at a Congressional hearing on the Sleeping Bear Dunes Lakeshore proposal in Michigan, a research assistant of the New York Botanical Gardens said "Some Botanical and Conservation Organizations in Michigan have voted to support the bill, but I believe the only reason is that they fear the bulldozer more than the tourist. Basically they view the onslaught of thousands of people with less than enthusiasm. To open up a region for camping and the mass movement of visitors goes against all conservation principles."

If it is true that we will be short of wild land for recreation in the future, it appears logical to guard against over-developing the forests for intensive recreation. A few recreation people are promoting the idea that the place for modern camp and picnic grounds is in the agricultural areas adjacent to the forests.

Besides the conflict between developed recreation and wilderness, we have conflicts between hikers and cyclists, and between fishermen and water skiers. In the wildlife area we may have conflict between the interests of deer hunters and turkey hunters, and we will probably have more between advocates of "put and take" trout fishing and those who think more streams should be designated as "fish for fun" streams.

The new Allegheny Reservoir may present another set of conflicts. Some will want natural shorelines and scenic control of adjacent land. Others will want maximum shoreline development with marinas, docks, diving boards, and similar facilities.

Conflicts of these kinds can sometimes be eliminated and can often be minimized by compromise, by some type of zoning, or by timing; but, everybody can't have everything. The best we can do to minimize inevitable conflicts is to have sound plans for the coordinated use of all resources, based on our best estimate of long range public needs; anticipate the reaction of our management on all who will be affected; and explain in advance our objectives and plans.

Another problem is that of getting more information on how each resource should be managed. We need more information on all phases of timber utilization. We need all kinds of research in forest recreation especially on the sociological aspects. We know far too little of our basic resource, the soil. Most of the published soil surveys covering the Appalachia counties stop at the edge of the woods, classifying the forest soils as "rough mountain land suitable only for the production of trees" or as "rough stony land."

The principal product of the National Forests, from the standpoint of meeting people's needs, both on and off the forest, is water. This is another resource we know next to nothing about. Other speakers will talk about some of these things.

It seems certain that more land will be devoted to primary uses other than timber production, especially recreation. It also seems certain that wildlife will always be of great enough value to require modifying timber management practices to improve habitat, if not to provide single purpose management areas. To balance the resources available with public need, the forest manager needs more information. General purpose forests grow timber, provide scenery, produce wildlife, and give protection to watersheds. In each forest area the question is: what is the relative worth of the various products of

the tree--the fiber for industry, the mast and browse and cover for wildlife, the beauty for recreation, and the leaves and litter that affect the forest's watershed function?

There are similar questions to answer about the other forest resources. What is the highest use for deer; as venison, to provide sport and recreation for hunters, or as a goal for sightseers and photographers?

We need more information on what people need from forests, and the changes taking place in their needs and in public values. This lack of good information on public needs forces us to make assumptions. We've been doing this in practicing multiple use on the National Forests for many years. In timber management we've modified practices in the name of preserving values without knowing much about it. We had to make assumptions but the validity of some of our assumptions was questionable. We required that stumps be cut abnormally low along roads or in recreation areas where people might see them. I don't know if this was done on the assumption that recreationists think that low stumps are pretty and normal stumps ugly, or whether we were trying to hide the fact that the timber resource was being utilized. We're beginning to find out now that most recreationists don't object to managed forests. Stumps are not ugly. A weathered stump of white pine or a moss covered hemlock or hardwood stump may add beauty and interest for the public using our roads and trails.

We used to specify a 200-foot, no-cut roadside screen. Beyond the screen a clear cut area might be visible giving the no-cut screen an artificial appearance. Sometimes an opening full of luxurious vegetation could be seen behind the no-cut screen. The goal in roadside cutting should be to improve esthetics and add interest for the traveler. Often this may require cutting out to the road edge to provide a variety of vegetation rather than a continuous no-cut screen along miles of forest roads.

A study under way in the Pacific Northwest is an example of the kind of research that will help in some of the multiple use problems. This study was reported on in a meeting held in R-6 on the subject "How to Manage Timber in Landscape Management Areas," that is, timber along roads or adjacent to recreation areas and timber on hillsides visible from the roads.

In that country the dependence of the local economy on the timber resource is critical. The need to preserve esthetics in the landscape management areas is equally important. In this study started a few years ago, cutting of several intensities was carried out along roads. The purpose of the study was to compare the values involved in the various intensities of cutting. The economics of cutting, the dollars and board feet, was easy to get. How to assess the effect of cutting on esthetics was a more difficult matter. As I understand it, they

made photos of each cutting area as seen from the road and asked a sample of people for their reaction. This process will be repeated every few years as regeneration develops and an attempt will be made to evaluate the effect of cutting on the esthetic sense of the beholders.

A similar study might help us decide how much cleanup is required in road construction to keep a roadside attractive. How much can we afford to pay to dispose of the stumps pushed from the roadway? This job costs a lot of money but some of us suspect that the esthetic sense of travelers is not greatly disturbed by stumps visible from the road.

We're beginning to get some of the information we need along this line from forest recreation research but we'll still have to make assumptions. Lacking facts, we couldn't operate without assumptions. We should, however, continually check and question the validity of the assumptions we make.

We need to be alert to changing public values. We can't afford to go too far out on the limb in predicting the status quo in any of the present demands on the forest by the public. There are many examples of changes taking place in the value the public places on the wildlife resource. An Advisory Board appointed by the Secretary of the Interior to review Department predator control programs recently said: "As our culture becomes more sophisticated, wild animals begin to assume recreational significance. Americans by the millions swarm out of the cities seeking a refreshing taste of the wilderness of which animal life is a living manifestation. Some come to hunt; others to look or to photograph. Some species have social values far in excess of the damage they cause. For every person whose sheep may be molested by a coyote there are perhaps a thousand others who would thrill to hear a coyote chorus. In many California forests, the esthetic value of coyotes exceeds any potential damage they might cause."

Another example of changing values is the Kirtland Warbler. This little songbird is considered to be of enough value to justify a special management area in Lower Michigan. On the Allegheny National Forest there are beautiful black cherry stands of high value, but in terms of future public values the blue heron rookeries on that Forest probably outrank the black cherry.

The future status of hunting is apparently a question to some. The President of the National Audubon Society spoke about static or declining license sales before a meeting of the Western Association of Game and Fish Commissioners last year. He recommended State wildlife agencies broaden their programs to include the conservation of non-game species, to seek appropriations from general tax revenues rather than relying on license sales alone. He conceded that fishing

revenues may still continue to grow because anglers will stand considerable crowding. But he said hunting cannot be crowded and retain any semblance of recreation. He thinks he sees signs that the peaking out point has already been reached.

Alfred G. Etter, Professor of Biology at the University of Michigan, has an idea that may deserve more consideration in the future. He wrote recently, "Cropping of wildlife may be a convenient scientific term but the constant implication that animals are nothing more than produce may lead to ridiculously low estimates of their true value--living things have values that go far beyond their worth as targets in the field."

Changes will take place in recreation. Emphasis in the future may be on the recreationist rather than the recreation area. Another University of Michigan professor said recently: "It's difficult to predict what outdoor recreation will be like in 1980. Jet-bottle hedge-hopping may replace water skiing." When I was in Upper Michigan I used to think that riding forest trails and logging roads on a motorized toboggan or cross country skiing behind one might some day grow like down hill skiing has grown.

According to the Lucas paper I referred to earlier, most research done in projecting recreation use indicates that the demand for wilderness type recreation is likely to continue to climb. He says: "It appears desirable while investing capital in recreation developments to try to keep a substantial area undeveloped for more primitive activities. This may be the most rapidly growing demand and a shortage of wild land seems possible. All of this land may not need to be pristine wilderness; some logging may fit in fairly well." Lucas also says: "It is important not to scatter scenic roads, campgrounds or cabins all over the forest. This scattered development may only use up a small portion of the available development sites, but it greatly reduces opportunities for more primitive recreation. Where resources are ample, public agencies and large private owners might well concentrate development into a few areas. This would preserve the back country while waiting for trends to unfold and would probably also lower cost of operation. Concentration might also raise the satisfaction of the visitors to the developments by making it easier for them to choose the type of development fitting their own special taste within a clustered part of the recreation complex." He recommends that flexibility in developing recreation in forest areas be kept high to roll with the punches we do not yet see coming.

This kind of thinking seems to have a place in Region 7. The Monongahela has an extensive Back Country area. This Back Country area has a road system developed for logging, but use of the roads by recreationists in motorized equipment is prohibited. Other R-7 forests are blocking off roads and putting them to bed following

logging. This practice serves a somewhat similar purpose in keeping parts of the forests from being too accessible for recreationists.

Finally, there is the problem of thinking straight regarding our responsibility as forest managers. Managing a public resource requires that we be sensitive to individual and group needs and desires. And it is quite a shock when you first come to the realization that everyone doesn't love multiple use.

Our responsibility as professional resource managers requires that we make decisions as objectively as possible. We cannot bend to the request of the most vocal single purpose interest. Our most important obligation is to present as effectively as possible our professional judgment as to the best path toward long range public benefit.

The action taken in connection with the Allegheny National Forest cooperative strip mining study is a good example of this kind of professional responsibility. This study is simply an attempt to find a way for legitimate owners of minerals to get at their property without permanent damage to other resources. When the study was announced, there was an outcry of protest. Regional Forester Droege wrote an article to explain the study in the Izaak Walton League publication. In it he said, "Citizen responsibility for the wise use of natural resources encompasses a great deal more than impassioned loyalty to specific uses of any one resource." The study is going ahead. An easier but less responsible way would have been to call off the study.

Our decisions in multiple use management may not always be popular but they should always earn us respect. Dr. George Selke, when he was Special Assistant to the Secretary of Agriculture, said at a Forest Service meeting: "There is one thing that I think we must be honest about and that is we must not surrender what we know is intelligent professional forest management. If we are going to hold the respect of the people, we cannot surrender what we know to be right in the profession which we represent. The truth will have to prevail."

A compelling reason for multiple use is the concern that most of us have that the combination of an "exploding" population and shrinking forest land will bring serious shortages in the commodities and services we get from the forests. In this connection, a talk made by Dr. George B. Cressey, Professor of Geography at Syracuse University, is reassuring. He said:

> "Today the world population is 3.1 billion and by the end of this century the figure may be almost double. Now let us look at the resources which may be available to feed and

support such numbers. Must mankind starve? Are we to run out of coal or nuclear energy? How rich is the earth and wherein lie its assets?

Here I am an optimist or potentially one. We may measure inches of rainfall or acres of good soil and we may compute tons of coal or iron ore. But what we cannot measure and what may prove most nearly inexhaustible is man's ingenuity. So far as resources condition the future, we have enough. What we do not know is how best to use them. People are resourceful and I see no limit to man's inventiveness or skill. Wisdom and judgment may be other matters, but the real measure of nature's assets lies in man himself. The earth is rich enough to support many people for a long time provided that man has the skill and ability to develop these assets wisely."

There is no doubt that there will be problems in multiple use management of the National Forests. It should be our goal as forest managers to develop the skill and ability to stay ahead of them.

THE STATE FORESTS--FOR MULTIPLE SERVICES

Ralph C. Wible
Pennsylvania Department of Forests and Waters

We believe that the State Forests and Parks should work for the people. To develop, protect, and manage these resources simply for themselves would be non-inspiring, non-objective, non-productive, and unchallenging. Today, people are closer to the forests than ever before. Rising appetites for raw materials--timber and water--plus increasing demands for recreation, impose new requirements upon public foresters. The concept of multi- or multiple-use is not new. Indeed, in Pennsylvania as early as 1900 the foundations for wise use were laid by our forebears, who, although they never heard of "multiple-use" enacted legislation: "To purchase, develop, and protect State Forest Reserves for the Welfare of the People"--These "Forests for the People" were to be developed through flood control, protection against fire, prevention of sedimentation of our streams, timber production, and other regulated uses by the people. And thus, from this early liberal declaration came: (1) protection against fire, (2) timber management, (3) development of State Parks, (4) advice to private woodland owners, (5) reforestation, (6) prevention of sedimentation of streams, (7) flood control, (8) conservation education, (9) other regulated uses, and (10) programs to solve social problems.

The officials of the State Forestry Agencies, as they manage the forest resources, are coming to realize that People and Forests are inseparable. Sometimes foresters are likely to be accused of managing the forests for the sake of the forests alone, ignoring the other great values so closely embraced with the woody resource. I cannot admit that this is wholly true since we are reminded daily of the personalized association in our dealings with legislators, recreationists, lumbermen, politicians, civic leaders, and industrialists.

As a representative of one of the Nation's State Forestry Agencies, I know that our job imposes upon us increasing responsibilities. Likewise, the opportunities are great. We believe that these opportunities challenge the best of minds and energies to bring to the people better understanding of forest values as well as wider usability of the private and public forest resources. This growing attention to public and private forests has paralleled the rise of economic and social needs of people and industry. The management and development of the State Forests need our best attention, not only to continue to be productive but to be used as examples to the small timber owner showing that quality wood products are needed in continuous supply. Private forests, as complex as the problem is, must gradually fall under an organized culture in this process of land use.

For example, one of the first humanitarian acts of the Department more than 50 years ago was the conveyance to the Department of Health some 1500 acres of the Forest Reserve for the construction of a tuberculosis sanitarium in the South Mountains. This was followed by the decision to make available, throughout the entire expanse of State Forests where not incompatible with other forest uses, camp sites to be enjoyed by thousands of families of the State. As a result of this action there has been built today, more than 4500 cottages and cabins on leased sites available for family or group vacationing, hunting, and fishing.

What is the Department of Forests and Waters doing for the people? One of the major objectives is the management of the 1,885,000 acres of State Forest land. Prior to the present program and during the first three decades of this century the Department had successfully completed the initial stages of land acquisition, surveys, and boundary establishments. Even in the beginning the prevention and control of forest fires was recognized as the most important task. Thus, under continuous protection the State Forests have grown to pole timber and sawtimber size. With the completion of the management plans in 1955 the stage was set for a sustained harvesting plan. The general objectives, as set forth by this plan, were:

1. Produce the greatest possible sustained supply of timber products.

2. Improve species composition and quality of existing stands and provide for adequate residual growing stock as well as reduce the damage caused by insects and diseases.

3. Regulate the cutting of timber so that the supply and flow of products from the forest will be constantly increasing until maximum production is attained. This will permit wood-using industries to cope with an expanding economy and tend to stabilize communities and the family life of workers.

4. Develop and preserve the recreational values of the forests.

5. Protect the watersheds from erosion and obtain from them the maximum yields of usable water for human consumption, fish life, and industrial uses.

6. Harvest timber in such a way that an adequate, uniform supply of food and cover for wildlife is produced.

Another surprising aspect of multiple-use is the development of mineral reserves under State Forest lands, the overwhelming bulk of which is natural gas. Almost 10 percent of Pennsylvania's gas production comes from these lands. Moreover, the exhausted gas fields serve as giant reservoirs for gas storage. The income from both of these operations as directed by legislature must be used for the construction of State Parks and flood control projects.

Another program provides that first offender teen-age youth are given a chance to learn of our natural resources when they are sent by the courts to one of three Youth Forestry Camps located at State Parks. Daily work programs supervised and integrated with sufficient teaching bring new views and outlooks on life to many. State Parks have their economic angles too--as illustrated by the claims of the City of Erie. The 3,000,000 persons who visit our Presque Isle State Park, according to the Chamber of Commerce, spend some $33,000,000 annually in the greater Erie area.

Forests can also be called upon to help solve the economic and social problems of the State by forceful conservation programs. A number of states are already on the move. Statewide projects for development of land and natural resources are in progress in numerous states, including New York, Wisconsin, New Jersey and California. In my own State of Pennsylvania a progressive program known as "Project 70" was enacted--a force for the state's progress in recreation, business, and industry. This project, requiring popular approval, proposes a $70,000,000 land acquisition program to preserve the enjoyment of Natural Pennsylvania land, converted into new opportunities for outdoor leisure and recreation. It will make the state more desirable to our present industry and help attract new ones. This is an investment in the future--an investment that will work day after day, year after year, for all the people. Urgency is of necessity, because we are running out of quiet spots, fish and wildlife are threatened, streams are polluted, and land costs are soaring. Yes, Pennsylvania needs this thoughtful and planned program of land use to meet our current needs and that of the 21st Century.

Today, the forest products industries of Pennsylvania use the services of at least 100,000 men. The total output of these industries, using wood from all sources, is well over $1,000,000,000 and the annual value of products produced from Pennsylvania timber alone is approximately $500,000,000. It is believed that the State Forests can continue to make an ever increasing contribution towards the economic health and wealth of the State by:

1. Stepping up the dollar receipts from timber sales to be deposited in the State Treasury.

2. Providing for hundreds of additional jobs in the primary processes--plus many more in the refining and refinishing industries.

3. A definite improvement will result in species composition, quality, and growth rates. The health of the forest will be benefited.

4. Benefits for food and cover for wildlife are attained. The harvesting of game and fish from State forest lands has always been a recognized popular use. Last year more than a quarter million hunters sought their sport of both small and large game on State forest land. Big game hunters harvested some 11,000 deer on these lands.

5. Increasing water yields are of great importance.

There is definitely a challenge to management of State Forests and public lands for the full benefit of the people. The realization and recognition of the interlocked character of natural resources with economic and social problems is the first step to take. As I said before, foresters must "come out of the woods" to see and understand as well as meet their responsibilities in the rapidly moving times of the sixties. The entire forest complex will then take on a new aspect as we view it in its possibilities for greater service. We no longer can afford to focus our attention wholly on forestry and closely allied problems. Wood products are not the sole aim of a forester's existence; even greater benefits can be attained if we raise our sights on the possible multiple values. I am certain that none of our early pioneers in conservation had any idea of the great potentials that were locked in the land, forests, and streams. State Forestry Agencies who manage small or large areas of public domain have great responsibility in meeting the demands of Man as a social animal in his quest for economic, social, and spiritual growth.

FOREST MANAGEMENT PROBLEMS OF THE PRIVATE OWNER IN APPALACHIA

Harold E. Matics
West Virginia Pulp and Paper

Private forest ownership in Appalachia ranges from many industrial owners, with large acreages, to the smallest of farm woodlots. However, since the Appalachian report indicates that over 70 percent of the region's forest acreage is held by owners who possess 50 acres or less, the problem becomes complex, indeed! Most of us who work in the forestry profession in Appalachia recognize the immediate problems in the area, inadequate markets, lack of access roads, the over-abundance of low-grade growing stock caused by forest fire, poor cutting practices and disease; and the complacency of landowners who lack the knowledge required to manage their woodlots profitably. But before we discuss the specific problems and their solutions, perhaps we should look at the past for some of the influences that have caused these problems.

Although forests have always had a large influence on the economy of Appalachia, and contributed much to the national economy during the early years of our country's growth, they have always been secondary to farming and coal mining. The landowners of Appalachia have never recognized the potential of the forest, the possibilities for sustained yield, or the benefits that could be received if it was operated as a permanent business. The original forests of the region were largely unbroken. As settlers moved in, the land was cleared with the thought being toward complete agriculturalization of the land. There was little, if any, planning and no thought of classifying land for its maximum use. Consequently, the forests have been affected more by shifts in the field of agriculture than by any other influence.

Second in importance to agriculture is the coal industry which is still the largest single resource and has caused many problems in unemployment and water pollution. Other important changes have been caused the movements of the lumber industry, the use of hardwoods by pulp and paper mills, and the establishment of the national forests. World War I and II caused radical changes in land use, as it did in other parts of the Nation. Consideration and knowledge of these influences are important in any discussion of forestry problems of the region. These influences have created the attitudes of the people and still affect their social problems which, in almost direct proportion, influence the problems of forest management.

With this background in mind, let us now discuss the problems of multiple-use management as it applies to the private landowner in Appalachia. In this relation, I think it is important that we first point out that with few exceptions land ownership in Appalachia is a home and environment to the owner rather than a business or economic way of life. There has been very little planning, either in farming or forestry, and many of the people have no permanent outlook or ambition. If a market is available, they exploit the resource with little concern for the future. The marketing of his forest products is undoubtedly the most important need of the private owner. Whether he owns a large acreage or a small farm woodlot, the private owner is interested in profit. Economics is nearly always the prime factor governing whether or not the owner practices forestry. To meet this need, we must continually work for better markets and to sell the products of the forest. Very few landowners can afford management practices that do not pay their way. Too many foresters are idealists and recommend practices that are the ultimate in theory, but far too costly to justify a reasonable profit. If we are ever to accomplish the job that must be done, we must practice forestry that is economically feasible. Field foresters must accelerate their efforts to divert the forest crops into the most profitable markets. We must continue to look for new buyers and develop new wood-using industries, as well as to expand those that are presently located in the region. Research in the field of forest product marketing must be continued and increased by both public and private capital, especially for small-diameter trees and low-grade products.

Another serious problem in Appalachia, and closely connected with marketing, is that of roads. Due to the mountainous terrain and soil conditions, road building has always been expensive and difficult. Public road programs have been largely based on population needs, and private roads have been built with only the thought of the immediate objective in mind. If there is to be a total realization of multiple-use management, a good program for multi-purpose, all-weather roads is a necessity. This is especially true when we think of recreational development and mechanization in the harvesting of forest products. The state and Federal agencies should be urged to prepare a workable plan for the building of suitable highways and rural roads for the development of the Appalachian economy. Private owners must in turn develop suitable access roads for the purpose of forest management on their land. Planning and laying out good woods roads for fire protection and silviculture purposes is the essential part of any good forestry program and one which foresters have been weak in promoting. Here again we are involved with economics but, in most cases, roads are one item that can be justified if the land is worthy of management. If an owner is convinced that he can afford to invest capital in land for the purpose of growing trees, then the additional investment for an adequate road system for fire protection, silvicultural treatments, and product harvesting becomes a necessity. Good roads

are also an important part of multiple-use management, as a well laid out road system promotes soil and water conservation and makes the property accessible for recreational use.

In addition to marketing and roads, another pressing problem in the Appalachian area is that of suitable woods labor. There are few professional forest employees. The forest industry is affected by farmers, mine workers, rural laborers and the existence of a class of chronically idle men known as the "unemployed". The unemployment problems in Appalachia are as much a burden to good forestry as a help. Many persons take advantage of relief and social welfare programs in that they work on a job only long enough to qualify for these benefits, and then remain unemployed until these benefits run out. Skilled loggers, woodsmen, and sawyers are at a premium and can obtain jobs paying good wages, and these opportunities seem to be increasing each year. Almost all logging operations in the area now report a scarcity of good labor. These problems are very difficult to solve, and many will argue that the forest industry will never be able to pay wages comparable to coal mining and other manufacturing. Here again, partial solution of the problem is closely related to better markets. I believe that much can be accomplished by training programs and vocational education for woods workers by the private and public sources and increased research in new methods of growing and harvesting forest crops.

Now that we have singled out some of the main obstacles to forest management on private land, as well as the sociological problems, let us review that which must be accomplished to achieve multiple-use forest management.

1. We must approach selling forestry to landowners on an economic basis.

2. We must expand present markets and create new ones, especially for small-diameter species and low-grade hardwoods.

3. We must improve road systems at all levels.

4. We must accelerate forest research, both by private industry and that of governmental agencies and universities.

5. We must improve both the quality and quantity of woods labor by vocational education and training programs.

6. We must change the attitude of the people toward the forest. This alone should help to solve the forest fire problem which has been deterrent to good forestry in many areas of the region for many years.

These tasks cannot be accomplished quickly, but the outlook for the Appalachian region is considerably brighter today than in recent years, not so much because of the recent publicity and the possibilities of the Appalachian Regional Development Act and the poverty programs, but because of the accelerated interest on the part of the private investors in the economic possibilities of the area.

To solve the problems of Appalachia, it is going to take the cooperation of the State, the Federal Government, and private owners. All must work to bring about an economically sound forest economy that will grow and expand into the widest concepts of multiple-use management.

WHAT TIMBER MANAGEMENT NEEDS FROM RESEARCH

Glenn E. Smith
Region 7, Forest Service

Forest management is a term encompassing management of all of the many uses made of forest covered land. My subject is limited to the field of timber management or timber production, a forest use that is and will continue to be a major objective for forested lands.

First, what areas of specialization are included in the timber production field? A partial list of biological and physical sciences would include soils, silvics, silviculture, ecology, genetics, mensuration, inventory, economics, utilization, logging, engineering, entomology, pathology and fire control. If management and research literature in all of these fields were collected, current knowledge in each area of specialization would fill a small library, a library growing yearly through expanded research and practice. Add to this the managerial talents required to operate a timber production operation, such as organization, programming, training, and financing, and the true magnitude of timber management planning and operations becomes evident.

What does management need from research to carry out a timber management objective? This is the topic to be discussed. Considering the partial lists of specialties above, all with many unsolved questions, we could end the discussion here by saying we need more research in all areas. Perhaps it would be better to consider the topic from the separate and different interests of first, the forest owner; second, his land manager; and third, his staff specialists. What does each one of these three managerial groups need from research to carry out a timber production objective?

Restated in this way, it is more obvious that answers to the question what timber management needs from research, must first consider ownership classes. Depending on ownership objectives, interests, and land potentials for timber production, research needs will be very different from different ownership classes. After ownership objectives are defined, it is obvious that the organization and manpower for the various timber management programs will be very different, and that different levels of the organization will have very different questions for researchers.

To illustrate the difference ownership will make in defining research needs, four forest ownership classes may be considered. Each make or require different types of management decisions, and at this time, each needs different research data to help in these decisions. The ownership classes are (1) large public ownerships, such as National and State Forests; (2) large private such as

pulpmill, sawmill, and other forest land holding companies and individuals; (3) profit seeking owners with small holdings of forest and combinations of forest and agricultural lands; and (4) small ownerships of mixed forest and other lands not held for profits from timber production.

In this listing, I have included forest holdings of over 1000 acres in large ownerships, and in small, all those less than 1000. Potentially, production from a 1000 acres of fully regulated forest lands in Appalachian hardwood regions could provide an owner about $8000 a year net income (based on yield estimate of fully productive lands of 350 BF and 1 cord per acre per year @ $40.00 per MBF and $2.00 per cord). The distinction between groups (3) and (4) is made to separate the increasing number of property owners who purchase forest and farm lands for summer residences, private hunting preserves,and other uses, from those who hold or acquire forest lands in expectation of income from the timber resource. Possibly, the two last groups could be further divided into two sub-groups, based on the percent of forest land in their holdings. Those with 50 percent or more of their total land holdings in forest cover could logically be expected to have more specific and different objectives and needs for timber production than those with less. However, for the purposes of this discussion, four ownership groups will suffice to indicate different research needs because of wide differences in ownership objectives, a need for income from timber, and production possibilities, particularly in relation to the total market for timber products.

Regardless of the size or purpose of forest land ownership, basic management policies are established by the owner in a management plan. His chief questions are on economics, organization, and programming. Large ownerships require the largest personnel organizations and usually employ foresters or use forestry consultants to advise them on policy questions. After basic policies are established by the owners (Congress or State Legislatures in the case of National and State Forests), definition of the policy, and establishment of the programs necessary to carry out policy decisions are the responsibilities of land managers. Again, large organizations are different from small ones in that the manpower used to carry out the owners' policies is more specialized as well as abundant. Large organizations usually can be divided into three or four branches--line or administrative, staff, supply, and service. In the case of small ownerships, the owner may carry out all the functions of the large personnel organization, or he may use State or other forestry consultants in the role of line-staff-service-supply advisors. However, all need better research and development information in the general fields discussed in the following paragraphs.

Until recent years, research in timber management economics has been rather limited. Only in recent years have economic models been made broader and more sophisticated to reflect more of the complex inter-relationships of the modern technological society and the timber industries. However, much remains to be done. In retrospect, forest economics research programs appear to have been too much influenced, controlled and directed by biologically trained and oriented foresters, and not enough by economists, forest land owners, and their managers.

Economics research has been hampered by inadequate and often inaccurate data on timber volume, growth, growth responses following various silvicultural treatments, and vague or poorly designed management plans and program objectives. As a result, forecasts of returns to be expected from timber management programs were very conservative and hardly a strong inducement for private or public investments in such programs.

To provide the input-output data for economics staff specialists, owners and line or administrative officers must look to inventory and silviculture staff specialists. In these two specialties research efforts have been concentrated in the silvicultural field, and limited in mensuration and inventory methods, at least until problems in National Forest Surveys forced some added attention on them during the 1950 to 1960 decade. For example, Al Bickford, station biometrician, for the Northeastern Station, made a major contribution to survey or inventory practices in developing an efficient, low-cost sampling system. In current inventory programs, the Station continues to refine various components of Bickford's basic system, particularly on growth measurements and electronic data processing methods. During the same period, the Southeastern Station contributed primarily to mensurational knowledge, developing several new field techniques that greatly reduced chances of technique errors.

A tremendous amount of silvicultural research effort has always gone into cutting methods. Considering the over 40 species of commercial value for sawtimber alone, the great variation in soil, site, type, slope, aspect, climate and past land use within the Appalachian hardwood forest region, it is not surprising, however, that major problems in regenerating stands to desired species, and in thinning stands on the best time schedules, continue to bother field foresters. Pressures on researchers from various individuals and management organizations to test and develop a tree marking and cutting method that by itself would produce desired regeneration on all sites and stand conditions, have handicapped efforts to develop better silvicultural guides. Greater research effort in the silvics of our many species, and in the physiology of trees, might have been more rewarding today to both owners and managers, for they are faced still with inadequate knowledge in

these basic fields. Thus, the difficult problem involved in regenerating stands to the best species on various sites, and controlling unwanted species before and after regeneration is secured, remains as a major research responsibility.

Exploratory forest tree genetics research was initiated over 30 years ago, but continues to be poorly financed and manned. However, results were significant enough by 1955 to start greater research efforts with hardwood species. So far as timber management is concerned, the meaning of genetics research findings in tree improvement programs is only now becoming known. It is possible to increase yield and value of many tree species, but only by a large, initial investment of capital in seed orchards, and later in site preparation methods prior to planting or seeding. After planting or seeding, still more capital must be invested to keep the superior stock free from competition with natural reproduction until the superior stock passes its critical juvenile life. Altogether, costs of growing forests of superior tree stocks are greater than with natural reproduction, and this is frightening to many land managers and owners. Also frightening is the greater staff specialization required and the greater mechanization, because this requires re-orienting organizations and programs. But, even with these greater costs, net returns to owners can be much greater, for rotation periods can be reduced by decades, often as much as 30 percent less than present rotations. It appears that compound interest rates can be jumped 1-1/2 to 2 percent for each 10-year reduction in the time needed to produce the tree sizes desired by owners.

A new era in timber management appears to have dawned about 10 years ago. Forestry is an exacting science today when compared to the diversity and intensity of practices of only 10 and 20 years ago. Owners of forest lands, influenced by the greater profits in production made possible by the technology developed after the World War II period, set higher financial objectives today than any generally thought possible to achieve before 1955. Timber managers, staff specialists, and researchers have been hard pressed to adjust to the changes caused by the increased attention to net returns from timber production efforts.

Some new problems of land management operations are developing for which research presently has little assigned responsibility. The new problems are in communication, education, and management control methods. Publishing of the new knowledge resulting from biological research is not enough to guarantee an owner high returns. New organization of forest land, manpower, and operating programs also are required. To go with biological and physical science research, owners and managers today need to revise and improve administrative management systems, operations, analyses, and educational or training methods. The role, if any, of forest research

in study and use of these three key management fields has not been defined. However, the rapidly increasing specialization in administrative management will require a definition of responsibilities for research and line officers. Large forest ownerships have the most pressing needs at present, for an analysis of their organization, operations, and training methods. Small ownerships will be faced with greater basic problems, for they will need to rely for advice on smaller personnel staffs, usually of generalists rather than specialists. Unless some method is developed to speed up the spread of new knowledge to the consultants used by owners of small forest tracts, the small ownerships will become even more of a problem in national timber management programs, for they will be even less able to operate at a potentially high profit.

Just as the traditional line-staff organization concept needs re-examination and some re-orientation, the specialized role of the staff officer charged with management planning needs analysis. Management planners traditionally have the task of establishing area and volume cutting objectives, short and long term growing stock and yield objectives, methods of cut required to carry out management objectives, and of prescribing other forest development and protection programs such as those for roads, and control of insects, diseases, and fire. Should his role stop with the plan preparation? It would appear better for land owners to pass on an added responsibility to the planning specialists, that of program evaluation and review after the plan is put in operation. Preparation of the management plan requires the planning specialist to delve into and consider all of the subject fields discussed thus far, plus several others, including a major one, the integration of timber production with other land uses and resources. Perhaps better than any other line or staff member, he knows the timing for placing various parts of the plan into action, and the results it should produce at various bench marks in such flow charts. However, almost all organizations divide responsibilities for program evaluation plan among various line and staff specialists, and do not rely on planning specialists alone. As most line and staff officers usually are involved full time in controlling, directing, and inspecting operational projects and programs, a complete review of the progress toward the management plan's short and long term objectives is seldom made until the planning period ends and a new plan prepared.

What does a timber management program need from research? Let me summarize my thoughts by listing what I consider priority or immediate needs.

For decisions by the land owner:

1. Economic analyses to define current and potential rates of return under both present and increasingly intensive levels of

management programs. Models should be designed to fit various ownership classes, not necessarily the 4 classes used for illustration.

For decisions by the land managers with the owners:

1. Studies to obtain more precise stocking, growth, and yield measurements and predictions for forests operated as sustained production units. Predictions of potential yields under various stocking levels and cutting cycles are needed. Yields from cuttings during a rotation period are reported from Europe as nearly equal to the final harvest cutting at rotation age. Such yields depend on short cutting cycles or periodic stand tending treatments. Very few estimates have been made of the volumes that could be cut during stand rotations in the Appalachian area.

2. Studies of management planning methods and management controls. The relationship of management planning, and program evaluation and review functions for land owners and managers needs evaluation. The late Arthur Meyer of Penn State University was one of the few men who pleaded for better plan controls, yield, stocking, and growth data. Fifteen to twenty years ago he presented some new ideas on timber management plan controls that, unfortunately, have had little further investigation since his death.

3. Studies of organization for timber production. Physical organization of land units and transportation systems for protection and utilization purposes probably are the most expensive single investments the owner will make in a production program. More research is needed to reduce costs. The personnel organization is another very expensive investment. Operations research is needed to define the individual roles and responsibilities of various administrative and staff personnel in order to utilize each man at each level most effectively for the timber production objective, and to properly schedule various programs. Overlapping and poorly defined responsibilities cause costly delays, especially when management controls for different programs rest at different levels of responsibility within an organization.

4. Study of education and training methods. Modern education methods, such as programmed learning, should be investigated as a means of spreading new research findings to the field, and training forest staffs in new techniques and practices. Delays of several years between formulation and general adoption of new techniques are costly.

Forest research organizations have concerned themselves primarily with the biological aspects of timber management. Items 3 and 4 generally are considered the responsibilities of the line officers. I believe there is a place for research study or development also.

For the Staff Specialists:

1. Tree improvement and genetics research on hardwood species needs strengthening. Additional high value species should be added to the research program.

2. Artificial regeneration measures will become more important to the practicing foresters with an expanded genetics program. Research on artificial regeneration methods for hardwood species should be expanded as soon as possible, and research with conifer species continued. Species-soils correlation studies are included under this subject.

3. Mensuration research--accurate measurements of tree volumes, including quality, are necessities in any management program. New instruments and measurement techniques for quick field measurements should be developed, and better tables, particularly for high value species.

4. Development of improved, low cost, inventory systems, including electronic data processing methods, for calculating measurements of volume and growth should be given a high priority.

Research studies should include inventories for forestwide management planning, as well as for planning programs and projects, such as preparation of cutting budgets and timber sales.

Basic but longer term research programs generally concern staff specialists at present. Additional studies are suggested in the following to reduce operating costs and increase probability of success in all management practices:

1. Management of forest soils through manipulation of stand structures and species compositions, and chemical applications. This research study is in addition to soils research required in regeneration studies.

2. Tree physiology, particularly flowering and fruiting structures and habits.

3. The relationships of forest growth and structures and wildlife populations, not a few troublesome species alone, but the total wildlife population living in forest environments.

4. The effects of climate on forests, and forests on climate.

WHAT WATERSHED MANAGEMENT NEEDS FROM RESEARCH

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Region 7, Forest Service

A first step in the determination of what Watershed Management needs from Research is the development of a picture of the water resource and its problems. This is a complicated subject and much of the information needed to present a clear picture is lacking. Since our interest is in the surface water resource and in that portion of ground water resource that contributes to streamflow, Research will be dealing with the water, the land, and its cover and use by man. Cover pays no attention to property or political subdivision lines; consequently the problem and its solutions are dependent on a study of conditions on all types of ownership, public and private, and all forms of use.

Let's start out with the area included in the 12 states comprising the territory of the Northeastern Forest Experiment Station. This area, extending from West Virginia north and east to Maine, includes about 7 percent of the total area of the United States and contains approximately 30 percent of the total population. About 60 percent of the total area is in forest cover and this percentage is slowly increasing. Consequently, it is easy to see that the solution of at least some of our water problems is going to depend on the management and treatment of forest lands.

We are dealing with a rugged country, with steep slopes and narrow valleys. There is little flat topography; topographic changes affect precipitation; there are substantial variations in rainfall; and runoff is rapid. Part of our area (about half) is glaciated, with complex soil structures, varied topography, and a wide range of soil conditions from very shallow to very deep and wide variation in drainage characteristics.

Forest cover conditions vary widely in accordance with past use and treatment. Effects of such cover differences are apparent in the infiltration rates, or rates at which precipitation enters the upper half inch of the soil profile, and in some cases, in the percolation rate or rate at which water moves downward through the soil profile.

Precipitation in the form of rain and snow is the source of our water resource. While this precipitation ranges from a high of over 70 inches annually on Mount Washington in New England, to a low of 30 inches in portions of the Potomac Valley, it has a general range of about 40 inches. Approximately 251 million acre feet of water fall each year on the forested lands of this area. This precipitation is fairly well distributed throughout the year

and there are no specific wet or dry seasons, although prolonged periods of drought or excessive flooding may occur in sections of the region at any time.

Runoff, or that portion of the precipitation which is not used "on site" through the processes of evaporation and transpiration, or for replenishing ground water storage, varies from 10 to 40 inches per year, depending principally upon climatic condition changes with latitude. The further south you come, the greater the percentage of precipitation used "on site". While we have no total figures on runoff from all forest land, data worked up for 2,233,000 acres in the four National Forests in the area indicate a runoff of about 5,000,000 acre feet annually. This is equal to about 715,000 gallons per acre, or an average runoff of 27 inches. This is probably higher than the runoff for the region as a whole, since the National Forests generally occupy the higher headwaters elevations where precipitation rates are highest, where average temperatures are generally lower, where growing seasons are shorter, and where evapotranspiration losses are lowest. Taken as a whole, I believe we can safely assume that the approximately 75 million acres of forest lands of this area produce an average of 23 inches of water annually. This is generally high quality water, suitable for most forms of domestic and industrial use.

Consumptive use of water in the Northeast is relatively low in comparison with the total amount of water available. Properly distributed in time and place, we have plenty of water to meet all present and immediately foreseeable future needs in the region. Although our precipitation is quite evenly distributed throughout the year, our runoff is not. At times, the on-site demands of the vegetation in the watershed may claim all of the available precipitation falling during the growing season and, in addition, any moisture stored in the soil profile, thus substantially reducing runoff during such periods. This same watershed may contribute runoff in excess of stream capacity during storm periods or during spring runoff of melting snow. For example, the 4,000 square mile Potomac River drainage above Hancock, Maryland, produces an average annual runoff of 3,993 cubic feet per second, or almost 1 cubic foot per second per square mile. The maximum recorded runoff at this point, however, is 340,000 cubic feet per second (C.F.S.) and the minimum is 609 C.F.S. Similarly, the Williams River, just over the hill from here, on a 128 square mile drainage area, has an average runoff of 306 C.F.S., or 2.46 cubic feet per square mile and a maximum runoff of 22,000 C.F.S., with a minimum of one-half a cubic foot per second.

Thus, we have the problem of too little water at certain seasons of the year and too much at other times and these problems vary in accordance with many factors. We also have the problem

created by the harvesting and utilization of other forest resources. It can well be said that instead of having one big problem, we have many little problems to solve in Watershed Management. This gives us a basis for determining some of the Research needs.

It is quite apparent that the research guided toward the solution of watershed management problems should be focused in the following directions:

1. Toward reducing excess flows.

2. Toward increasing low flows.

3. Toward maintaining and improving water quality.

4. Rehabilitation of disturbed areas.

5. Determination of the value of water.

6. The effects of multiple use management on the water resource.

The first two might well be combined under the broad term of control of water yield.

Many of the answers needed for solution of water yield problems will come from studies of fundamental hydrologic process, such as precipitation duration and intensity, soil moisture storage, evapotranspiration, infiltration, and percolation of precipitation, snow accumulation and dispersal, frost formation, ground water accumulation, etc. It is the realm of the research scientist to develop the series of fundamental studies which will eventually blend into a solution of the water yield problem. Our need is for better information on how to handle the land, its cover and resources to influence water yields in the proper direction. Proper blending of fundamental or basic studies of the above listed processes will give us many of the answers.

Water quality studies are needed. They should include ways and means of rehabilitating scarred or disturbed areas which produce excessive quantities of runoff and sediment. Studies to determine the effects of forest conditions and practices and the effects of harvesting and utilization of other resources on water quality, together with a determination of the corrective practices needed to eliminate or minimize bad effects, are highly important.

Studies of the harvesting and utilization of underground resources and the correction of unsatisfactory conditions created by such operations present a wide field for research, as increasingly larger areas are being disturbed.

In these days of economic justification of everything except trips to the moon, we need more economic studies and better data on the value of the water resources. Without such information, it is difficult for the land manager to decide whether his water resource problems can be solved best by land treatment measures, by structural installations, or by a combination of both. Far too little attention has been paid to this subject in the past.

Is water valueless until someone confines it behind a dam or in a pipe? One might say that it is a natural product resulting from the deposition of rainfall on a given area, regardless of cover conditions. Does the investment of capital in land treatment create a water value in the same way that installation of a retarding or diverting structure creates a value for the water thus impounded or diverted? Land managers and land owners react to monetary, rather than aesthetic or intangible, values. Real watershed management will be applied when either tangible values are placed on the resource itself or on the enjoyment made possible as a result of the presence of the water resource.

The forest lands of the area have many resources and many uses. In the past, most of the management applied has been for the development and utilization of the timber resource. Demands for recreational use are increasing rapidly. Water demands are increasing and the days of single use are numbered except for special areas. Private landowners controlling about 93 percent of the forest land in the Northeast must adjust management to accommodate these uses or perhaps see the land placed under restrictions which, although necessary for the public good, may not be in the landowners' best interest. In short, research is needed in the application of multiple use management on all forest lands in order to permit full and effective use of all resources with minimum detriment to the water resource.

FORESTRY RESEARCH IN APPALACHIA--
PAST AND PRESENT AT THE UNIVERSITIES

Earl H. Tryon
West Virginia University

I have been assigned to cover research--past and present by three forestry schools within Appalachia. They are Pennsylvania State University, Virginia Polytechnic Institute, and West Virginia University. I wish to thank Bob McDermott of Pennsylvania State University and John Hosner of Virginia Polytechnic Institute for aiding me in obtaining background material. However, don't hold them responsible for interpretation of results or for opinions. I should also thank Warren Doolittle, but he got me into this, so I'll not.

The participation of an instructor of a University in a research effort involves many angles, and benefits occur in many ways. Through his research he finds new ideas or methods. This is the usual reason for research, and he feels a sense of accomplishment and contributes to knowledge. Of considerable importance is the fact that research keeps the instructor on his toes. It forces him to keep up with new work in his field, have up-to-date notes, and reduces the likelihood of stagnation. Often research contributes more to the growth and competence of the instructor than he contributes through his research efforts.

If we study the research accomplishments of forestry schools, we find that research related to timber management is broad in scope, and all aspects cannot be covered in only a few minutes. Also, I think that within the schools we have tended in the past to put a limited amount of time on studying a specific problem and then moved on, rather than concentrating men and funds on a program. For example, an instructor with a heavy teaching load may find only limited research time, or a graduate student may have a special interest which he develops in a thesis or dissertation.

Past Research

1. Reforestation of spoil banks

The first attempts to plant spoil banks were haphazard and the results were of little value. However, about 1945 the legislatures of both Pennsylvania and West Virginia passed acts requiring revegetation of these spoil banks. The foresters were now required to tell groups what species to plant, and when and how to plant them. Regeneration research started at this time and classifications of spoil banks were developed. The classifications originated because the characteristics of the banks were so variable. Both

seeding and planting tree species have been tested. In general, planting has proven more successful than seeding. Approximately 18,000 acres have been seeded to black locust in West Virginia, and the results of a recent survey indicate that establishment was successful on only 20 percent of the banks (1). Several hardwood species were seeded in Pennsylvania, and the results were erratic but generally poor. Here spring-sown red oak gave the best results. Reports of planting results in Pennsylvania by Hart and Byrnes (4), and in West Virginia by Brown (2) showed the following species to be growing successfully on the spoil banks.

Pennsylvania

Species	% Survival
Hybrid poplar	45
Black locust	60
Red oak	62
Jap larch	42
Jack pine	38
Scotch pine	80

West Virginia

Species	% Survival
Black locust	69
Scotch pine	66
Red pine	71
White pine	69
Yellow-poplar	80
European larch	67

Steep outer slope and acid banks continue to constitute difficulties in revegetation. Indications are that acid banks (pH 3.0) will remain acid for many years and support little or no vegetation. The productivity of these banks is still a question as so many of the plantations are young. However, there is some indication that timber crops may be raised on certain spoils. One study of tree growth on old iron-ore spoil banks showed that oaks grew well to an age of 60 years (5).

2. Christmas tree production in plantations

When growing Christmas trees in plantations, perhaps the principal concern is the production of a high quality tree. All research seems pointed to this end.

The season for shearing trees to give them a desirable form has been investigated for the pines and spruces. The pines respond best to mid-summer shearing although both Scotch pine and

red pine may be pruned in the winter. This winter pruning will maintain a good form, but reduce the growth. Spruce may be sheared in any season although summer shearing is less desirable. Slope pruning (45° angle) reduced the number of multiple leaders on flat pruning of Scotch and red pines. The yellow winter color of Scotch pine has been a major problem of the growers. Work is underway to improve the color artificially by spraying the yellow foliage with dyes. Some attention is also being given to seed source of Scotch pine in an attempt to find strains which maintain a green color during the cold winter months. This approach seems to be the second best bet to solve the problem. The best way is to stop growing the species. Also the cause of the discoloration has been studied.

3. Research in the general management area

The general area of timber management has received much attention in the past particularly at Pennsylvania where specific studies on methods of forest growth determination, normal stocking of oak stands, stand structure, and cruising techniques have been conducted. In West Virginia work is and has been underway in cooperation with the Island Creek Coal Company. Ways of managing rather abused stands for a profit are being studied and actually cover silviculture through utilization research.

4. Other areas of past research

Investigations also worthy of note are:

Chemical control of woody and herbaceous plants. Work has been done on power line rights of way, brush control of old fields, and control of sod in Christmas tree plantings. Also, intermediate cutting, pruning, and site problems arising from adverse climatic factors have been investigated.

Present Research

Perhaps the most important note I might strike here is to hail the recent passage of the McIntire-Stennis Act which provides funds designated for forestry research for the forestry schools. This is Federal money, and must be matched by the institutions. The past year has seen many research projects activated under this act throughout the country. A total of 158 projects are being started (6) and many are in the field of timber management or closely related areas. This act will strengthen the forestry research programs throughout the country and in Appalachia, and will be especially helpful to small schools which are not too well financed and to schools which have depended on Agricultural funds, such as Hatch for the majority of the financing of research projects.

Here are some of the areas of present or new research.

1. Tree improvement

Work is underway on tree improvement of our valuable hardwood species. Such species as black walnut, black cherry, and red oak are included. This work stresses wood quality of superior trees. From the located superior individuals, seed blocks will be developed for the production of high quality seed.

One of our problems will be the ways of introducing superior hardwoods into our hardwood stands.

The regeneration of our hardwood stands, where forestry is practiced on hardwood sites, has been by the use of known natural regeneration methods such as the shelterwood, group selection, or clear-cut patches. The cuttings are, or should be, made in such a manner that the new crops originate as progeny of the existing mature stand without the introduction of new genotypes. On the contrary, new genotypes are commonly introduced to an area in an artificial regeneration program involving planting or seeding.

I believe that these same natural regeneration methods will be used in the future as the hardwood stands are cut for the purpose of harvesting a crop and obtaining reproduction. Where forestry is practiced, the future stands will be improved by continuing to favor the desirable phenotypes on the area. However, the introduction of superior stock, perhaps by direct seeding in areas where the natural regeneration cuts have been made might be used to supplement and hasten the change from poor quality to higher quality stems, and result in a more productive and more valuable stand.

Attention is being given to this problem with a start being made using group selection openings of different sizes and then seeding and planting hardwoods (superior stock).

Another facet of the hardwood tree improvement work is the research on the use of systemic insecticides to control the weevil acorns of mature oaks. Weevil damage to acorns is high and increasing the amount of sound acorns, especially from superior oaks will be important. Recent work unpublished in forestry literature indicates that the use of ground applications of granular phorate and Di-syston reduced acorn weevil damage from 58 percent in untreated oaks to 35 percent in treated oaks (3). Continued work goes on using trunk and root implantation of the chemicals.

Work is also now underway involving the selection and breeding of white pine for weevil resistance. A successful conclusion to this project should be of great benefit to our reforestation programs.

In the Christmas tree areas, the production of quality trees and site adaptation continues. The large acreage of Scotch pine has led into an investigation of methods of marketing the species in a predominantly import balsam fir market.

Under past research, Virginia Polytechnic Institute was not mentioned. Their work in the area of timber management is just starting as no member of the research staff has been employed more than two years. Two projects getting underway are:

(a) Parameters of site for certain tree species

The purpose of this work is to evaluate the effects of certain environmental factors on the growth of tree species in Virginia. Also an attempt will be made to develop reliable means of predicting site quality by evaluation of the environmental complex in any given area.

Considered in the environmental complex are soil, (especially soil physical factors), climatic data, (especially precipitation and air temperature), and biotic factors, (especially stand density).

Another phase includes the effect of moisture and fertility levels on nutrient uptake and growth of yellow-poplar, Virginia pine, and loblolly pine.

(b) Epicormic branching of hardwoods

The ultimate aim is to develop useful guides for intermediate cuttings in hardwood forest stands in order to minimize loss in wood quality.

Being studied is (a) the tendency among hardwood species and among individual trees to form epicormic branches under different environmental conditions, and (b) formation of epicormic branches under varying environmental conditions following stand manipulations which affect density and crown relationships.

Concluding Statements

As we look to the future, I believe that we will do much more research, and find a greater amount of cooperation among the different agencies or units involved in forest research. The situation now is such that the forestry school can do more research which will involve training more young forest scientists. Although I have not talked much of research related to our hardwood stands, I believe the emphasis here will be on site and on quality timber.

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TIMBER MANAGEMENT RESEARCH IN APPALACHIA BY THE CENTRAL STATES FOREST EXPERIMENT STATION

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Central States Forest Experiment Station,
Forest Service

My task is to present the past results and present programs in Timber Management Research conducted by Central States Forest Experiment Station and directed to, or applicable in, Appalachia.

Obviously I can't cover our whole program in fifteen minutes, so I'll touch only a few of the highlights: hardwood planting, especially hardwood seed orchard development, soil-site research, natural regeneration, and stand density.

On old fields our hardwood timber plantings have been generally disappointing. This is a polite way of saying that most of them have been outright failures. In addition to the usual destruction by rodents, Bry Clark has shown that many of the failures are probably associated with poor soil structure and a low level of mycorrhizal activity in old field soils. Thus there appears to be little hope for successful hardwood plantations on old fields until soil structure on old-field sites has been improved following the introduction or invasion of pioneer species.

Hardwood plantings have done much better in forest soils on cutover sites, but since we get an abundance of natural reproduction on such areas, our hardwood plantings will aim to introduce or increase the amount of scarce, high value species on the better forest sites. On these sites we recommend using large planting stock with large root systems, and planting it deeply and carefully. So far, however, we have found no foolproof method.

Expensive site improvement and planting methods justify using only the best planting stock. Our seed orchard development studies, all in hardwoods, aim at providing superior seed in quantity. Yellow-poplar was the first species we worked on. The biggest stumbling block was propagating it vegetatively. After we had succeeded in killing off several thousand seedlings and cuttings, Dave Funk perfected a bud grafting process that is yielding around 20% success at the end of the first year. We now have quite a few budded plants at Marietta State Nursery. First outplantings of this bud-grafted stock in a yellow-poplar seed orchard have been in the field for two drought years now, and if we ever get some rain we expect many of the trees to live and grow, if the groundhogs don't eat them all in the meantime.

Yellow-poplar is insect-pollinated, and the insects rarely work more than one tree at a time. Moreover yellow-poplar has a high degree of self incompatibility. By bud grafting scions from two or more widely separated trees onto the same root stock, we hope to increase the germination percent greatly. This is still only a hope, however; we have yet to produce the first yellow-poplar flower in our seed orchard.

While waiting to see if some flowers will develop, we have switched our attention to northern red oak. Again the first step will be to develop a satisfactory method of artificial propagation; this work has just begun in cooperation with Purdue University.

Our soil-site research in the Central States is headed up by Will Carmean. I will mention it only briefly because Dick Trimble has done much soil-site work in West Virginia and is thus in better shape to talk about it with direct reference to Appalachia. Nevertheless I feel I should mention Will's work because it is quite well along, because it is an important segment of our program, because it applies in southeastern Ohio, and because a start has been made in eastern Kentucky, both of which areas are part of Appalachia.

Briefly, this work consists of correlating measurable features of soil and topography with the growth rate of forest trees. With the help of George Furnival, now in the Washington Office, and Bob Wilson of the Northeastern Station, regression equations describing the correlations have been calculated for black oak growing on southeastern Ohio residual soils. These equations allow us to predict site quality for black oak on our forest soils with an expected accuracy of about 85 percent regardless of the condition and appearance of the present stand.

For field use tables of varying complexity can be prepared from these equations depending on the use to which they will be put. Use of the most accurate table would require an evaluation of topographic position, aspect, texture of the subsoil, depth of surface soil, slope shape, and slope steepness.

Where less accuracy is required less-complex tables can be prepared. For example a very simple table will include only topographic position and aspect. Its expected accuracy is around 75 percent.

As I mentioned, this work is complete for black oak in southeastern Ohio. Field work has been completed and statistical analyses begun for white oak, chestnut oak, scarlet oak, and northern red oak in Ohio. Some field work has begun in eastern Kentucky.

Much of our other work in Ohio and Kentucky deals with natural regeneration of upland hardwood stands, particularly to find the harvest cutting methods that will yield the most satisfactory reproduction. Perhaps the most significant thing we have learned is that if our goal is simply to perpetuate Central States woodlands without regard for species composition or growth rate, it doesn't matter what kind of harvest cut we use. Timber trees are the climax vegetation in our area, and short of perpetual plowing or clearing the ground and paving it, there seems to be no way to prevent trees from taking over again.

Once this point is recognized, it becomes a case of selecting the regeneration method that has the most utility. For illustration we might compare the results of three methods of cutting: first, a single tree selection cut that removed 1/3 of the original stand; second, a heavy commercial high grading that removed 2/3 of the original stand; and finally, a complete clearcut that removed everything.

Two years after these cuts were made, we found considerable differences in composition of the reproduction (table 1). It appeared that the heavier the cut, the more yellow-poplar we got; the lighter the cut, the more oaks. Five years later, the picture had changed. Although the number of yellow-poplar per acre still closely followed the intensity of cutting, the number of larger oaks per acre was about the same regardless of the kind of cut made (table 2). Another difference was that only in the clearcut plot was the reproduction developing well.

Table 1.--Natural regeneration two years after harvest cutting of different intensities, Vinton Furnace Experimental Forest

	(Stems per acre)		
	All basal area cut	2/3 basal area cut	1/3 basal area cut
Oaks	2960	5140	9310
Yellow-poplar	6340	3020	1180
Others	2270	1600	2290
Total	11570	9760	12780

Table 2.--Natural reproduction more than 4.5 feet tall seven years after harvest cuttings of different intensities, Vinton Furnace Experimental Forest

	All basal area cut	2/3 basal area cut	1/3 basal area cut
Oaks	590	810	590
Yellow-poplar	550	290	40
Hickory	370	610	450
Others	1610	480	410
Total	3120	2190	1490

Ten years after the first cut, the understory in the selection tract had changed relatively little. It was brushier but very little taller than at the time of the cutting. Except in openings, hickory, dogwood, and red maple dominated seedlings and advance reproduction of oak.

By contrast the new trees in the clearcut plot were 20 to 25 feet tall after ten years, and both yellow-poplar and oak were numerous in the main canopy.

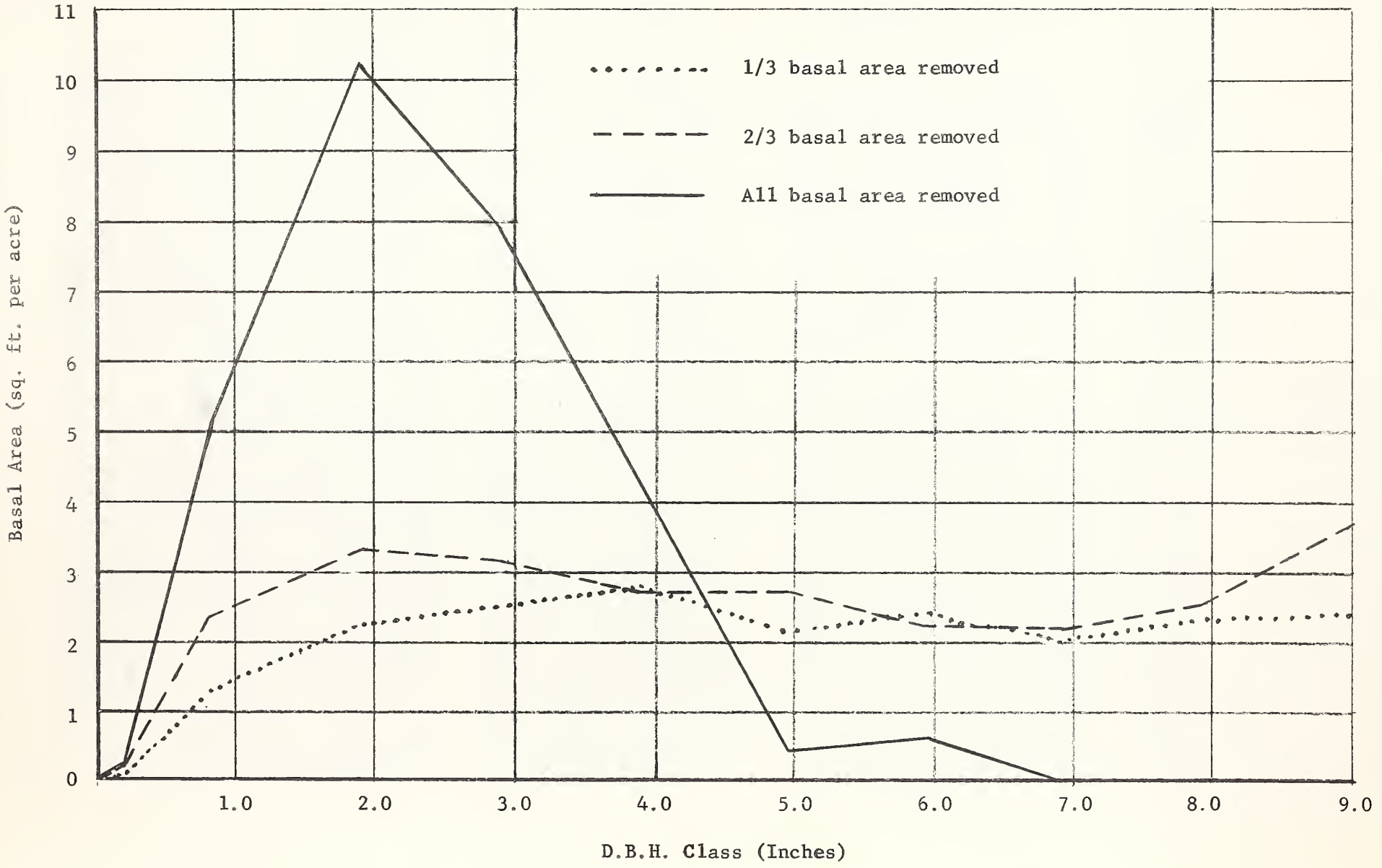
By 10 years after the cuttings, the clearcut plot had more trees in every diameter class up through 4" dbh than any other treatment (fig. 1), and all the other plots had some 2, 3, and 4 inch trees to start with. Evidently, the species we want, including the oaks, are too intolerant to develop under even partial shade.

Since these early days, we have gone into much more detail in our studies. In addition to a number of partially cut plots, we have installed more than 80 clearcut patches to see how often we can count on similarly good results. We have consistently achieved good reproduction.

We have learned that between 1/8 of an acre and at least 40 acres, the size of clearcut patch makes no detectable difference in species composition. However small patches have a larger percentage of area in a slow growing border zone created by shade from the surrounding stand. Also, because the ratio of perimeter to area is greater in small patches, small patches expose relatively more trees in surrounding stands to epicormic branching and loss of quality.

We have learned not to leave pole sized trees to put on more growth after a regeneration cut that removes the rest of the stand. They become worthless for products and usurp valuable growing space in the process.

Fig. 1 Stand development ten years after harvest cuts of different intensities



We have learned that there is no need to leave seed trees. Yellow-poplar, and probably ash and cherry seedlings come from seed already present when the cut is made, and all regeneration of these species that survives in the next stand comes in the first year after cutting. Thereafter it is too late. Successful regeneration of oak, hickory, and probably some other species depends on advance reproduction being present at the time the cut is made, but the more of this advance reproduction of desirable species that is smashed down during logging, the better. It is then transformed quickly into rapidly growing seedling-sprouts of good form and vigor. By comparison with growth rates of advance reproduction and new sprouts, new oak seedlings that come in after the cut is made don't stand a chance; they grow too slowly. In studies made by Steve Boyce at Carbondale, seedling sprouts of oak averaged 14 feet tall six years after clearcutting. Oak seedlings that came in after the cut averaged about one foot tall after six years.

We are currently turning our efforts to more intensive studies of regeneration. For example, the trend of ecologic succession seems to be away from oaks and toward more mesophytic species on good sites. We want to learn how to ensure more numerous oak regeneration on these areas, for these are the sites we must count on to grow high quality oak veneer. Also we wish to learn if we can shift composition from one species of oak to another on various classes of site. Finally we want to learn what regime of stand density will promote the formation of oak advance reproduction from oak seedlings, and put this advance reproduction into condition to become rapidly growing seedling-sprouts when the regeneration cut is made.

I'd like to back up a minute now and philosophize, if you'll forgive my oversimplification. It seems to me our silvicultural research should answer three main questions: first, on any particular site, what species will grow best? We expect the soil-site research and related studies to provide most of the answers to this question. The second question is, once we know which species should be growing on the site, how do we get it there in adequate numbers? We expect our regeneration research, both in natural and artificial regeneration, to help answer this question. The third question is: after we get the species there, how densely should it be grown to produce a full crop of the desired products most efficiently? For answers to this we are depending strongly on our stand density studies headed up by Sam Gingrich from our Columbus office and personnel at our Berea, Kentucky Research Center.

The story goes like this: when stands develop normally there are many trees per acre, but each has a minimum of growing space. Some trees are crowded out and die; the ones that live grow slowly, in diameter.

At slightly lower stand densities, trees have more growing space, develop larger crowns, and grow correspondingly faster in diameter.

As stand density is decreased still farther, a density of stocking is reached at which each tree has all the space it can use, but no more than that. This is the lowest level of stocking that will still fully occupy all the growing space, and at this level diameter growth on individual trees approaches a maximum.

At even lower stand densities some growing space is wasted, yield of products is reduced, and heavy branching excessively reduces timber quality.

Obviously to grow a full crop of trees to large size quickest requires maintaining stand density near the lowest level of stocking that will just occupy all the available space.

There is nothing new or startling about this description of stocking, but in the past we had no practical way to measure it. Recently Sam Gingrich has developed practical guides to give us a measurable standard of density on which to base silvicultural treatments. These standards are based on number of trees per acre and basal area per acre, both readily determined in the field. Knowing these two things we get an immediate picture of relative stocking of the stand, and how much we can cut without reducing total yield.

The biggest unsolved problem now is to determine what compromises will be necessary between attaining the most rapid diameter growth on the one hand, and achieving high product quality on the other. Compound interest being what it is, to make timber production economical we must grow products on the shortest possible rotations. We must either identify the density that will give us short rotations without promoting excessive branching, or we must find an easy way to prevent or get rid of the branches. We are now directing much of our effort to these problems.

Very briefly, Gentlemen, I have tried to cover the high points of our past work and current programs in Timber Management Research in the Appalachian area of the Central States: Site quality, regeneration, and stand density.

TIMBER MANAGEMENT RESEARCH AT THE PARSONS TIMBER AND WATERSHED LABORATORY

-PAST AND PRESENT-

George R. Trimble, Jr.
Northeastern Forest Experiment Station, Forest Service

In 1948 the Northeastern Forest Experiment Station established a field unit to conduct research in forest and watershed management in the Northern Appalachian Mountain region. The Fernow Experimental Forest near Parsons, West Virginia is the main locale around which the research program has been built.

The Fernow, a 3,640 acre tract on the Monongahela National Forest, was set aside about 30 years ago as an outdoor laboratory for studies in managing mountainous forest land. In the early years the Southeastern Forest Experiment Station was responsible for the work here. During that period the forest was organized, some boundary marking and mapping done, and a few studies carried out. After World War II, West Virginia and the Fernow were incorporated in the Northeastern Station's geographic area. Following several changes in name and a switch in headquarters location from Elkins to Parsons, the research program is now centered in the Timber and Watershed Laboratory at Parsons.

Research efforts have been concentrated in the field of management, with particular attention to timber and water. To a small extent wildlife studies have been integrated with this work through cooperative agreements with other agencies. My account of the work will deal with the timber management research aspects.

The early timber research program was conceived and established based on the ideas of Les Harper, Sidney Weitzman, and Hank Sims. In large measure many of the early studies were established in response to needs defined in Weitzman's problem analysis. Because this early program was well thought out, it has served as a sound framework upon which to build.

From the beginning and until today our concept here has been to carry out a program with two objectives: One, to provide usable information to practicing foresters on local problems of immediate concern, and two, to engage in longer range and more complex research to solve problems of a more fundamental nature. There is nothing revolutionary about this concept. With the passing of time, emphasis in the research program has shifted from answering questions in the realm of "What happens?" to those in the "Why?" and "How?" realm. This means that more attention today is being given to research in depth. Considering this trend, our new Laboratory is most opportune.

Compartment Studies

Our earliest efforts were directed to the establishment of compartment management studies. These are still an important part of our research program. The principal objective of these studies, as stated in the working plan, is to compare roadside costs and returns for products harvested under different types of management. This is the long-range objective, but the studies are already yielding valuable information on logging practices, stand improvement, growth, reproduction, and timber quality. It could be said that our compartment studies are serving in four ways: (1) As long-range economic studies, (2) as long-range management and silvicultural studies, (3) as short-range studies in both fields, and (4) as the locale for a number of special studies not particularly related to the stated objectives of compartment management research.

Many short-term results have been obtained and the data published. These have, we believe, made a contribution to the practice of forestry in this mountain area. All told, about 30 publications have come from our compartment studies to date, or at a rate of about two a year since the beginning of this type of research.

Our compartment management work includes studies of the following types of management: (1) selection management at two levels of intensity and employing four different lengths of cutting cycles, (2) commercial clearcuts, (3) diameter limit cuts, and (4) three intensity-levels of even-aged management. These practices are replicated across three site classes; site indexes 60, 70, and 80 for oak:

Treatment	Site quality (oak site index)			Total
	80	70	60	
	--Number of compartments--			
Commercial clearcut	2	2	0	4
Diameter limit	2	2	3	7
Extensive selection:				
10-year cutting cycle	3	2	2	7
20-year cutting cycle	2	2	2	6
Intensive selection:				
5-year cutting cycle	2	2	0	4
Flexible cutting cycle	3	2	2	7
Even-aged management	3	3	3	9
Check areas	1	1	1	3
Total	18	16	13	47

Along with the compartment management studies we are carrying out work on two small forest properties--woodlot case history studies. Results to date have been reported in three publications.

Logging

As an integral part of our compartment studies--and as a necessary facility to much of our plot research--we have our own logging crew. We dispose of our logs under a cooperative agreement with a local sawmill operator. Logs are delivered by us to the roadside where they are picked up by the cooperator who pays the logging cost and in addition, pays appraised stumpage to the Treasury of the United States. Having our own crew has permitted us to control the research cuttings and do some types of cutting which would not have been possible with stumpage sales.

When work was begun by the research unit in 1948, one of the biggest obstacles to the practice of good forest management in the area was the status of logging methods then in vogue. Mechanization was little advanced and logging road standards deplorably low. We had to demonstrate the proper use of modern logging equipment and develop cheap and efficient skidding methods and skidroad layouts before we could arouse much interest in any but the more elementary forms of forest management. Once we had demonstrated that good forest management was compatible with reasonable logging costs, many private operators and landowners became interested in practicing forestry.

Our control of the woods work has enabled us to conduct a number of studies on logging operations, many of which have been published.

Other Research

To explain the results of our studies on management systems and to provide guides for application of these study results to other locations, we have been, and are, engaged in a number of special silvicultural studies.

Site Studies

Soon after work was started in this area it became obvious that forest land site quality--the potential of land to grow timber--varies greatly, even over short distances. Variations in site, accompanied as they are by differences in species composition and growth rates, obviously would have to be considered, both in studies of stand treatment effects and in the development of forest management and silvicultural prescriptions.

The most readily available and best recognized measures of site quality were the standard site indexes--the heights of dominant and codominant trees at 50 years of age. But site index can be determined accurately only from trees growing in undisturbed, reasonably well-stocked, even-aged stands. Many--probably most--of our forest stands fail to meet these conditions.

In 1953 work was begun to find ways of determining site quality from the site itself for the principal timber species in this general area. We started with the oaks because they comprise at least half of the timber resource in this area.

From this work an estimating equation was developed for well-drained, medium-textured soils originating from sandstone and shale in the Allegheny Plateau and Allegheny Mountain region of northeastern West Virginia and western Maryland. The following four variables were found to have a major influence on site: (1) aspect, (2) slope position, (3) grade or percent of slope, and (4) depth to bedrock. Results of this work have been published.

Another study has been made of oak site index on Belmont limestone soils in this general area and the published results should be out shortly.

Still another site study has been made on the medium-textured soils from sandstone and shale in the Ridge and Valley Province to the east of here. Analysis and preparation of a report are underway.

We believe that the results of the site study work have had considerable application to the practice of forestry in this area. Actually, we are only started in this type of research. Much remains to be done.

Reproduction

Reproduction studies are needed for a variety of reasons: (1) to determine the natural trend of reproduction associated with specific sites and specific management systems, (2) to determine species peculiarities in relationship to type of seed bed, shade, sprouting, release, and other conditions that bear on reproduction success, and (3) to study treatments designed to develop specific reproduction responses, such as new stands composed of yellow-poplar seedlings, stand renewal by black cherry seedling sprouts, or renewal of oak stands by shelterwood cuttings.

Most of our reproduction work to date has consisted of studying reproduction response to different management systems on different sites. Additional observations have been made of reproduction on some of the site study plots. The results of this work have been reported in several papers.

In connection with the study of reproduction response to management systems, information has been accumulated on reproduction in relationship to special environmental conditions. This phase of our research is now being emphasized. For example, with the cooperation of the Forestry Department of West Virginia University, we are making a detailed study of reproduction relationships to openings.

With particular reference to even-aged management, we are engaged in a stump sprouting study to learn more than the literature divulges about the effect of time of cutting, stump size, tree vigor and site on sprouting capacity in several species.

Growth

One of the most important criteria used in evaluating any system of forest management is the growth rate associated with it. Rate of timber growth is the basis of any management plan or cutting budget. We are studying two aspects of growth: stand growth and individual tree growth.

Stand Growth

Periodic 100-percent inventories are used in studying stand growth. Growth is being related to the forest-management system, site capability, and stocking level.

Stand growth is under study on the compartments and on a number of growing stock study plots. The longest measuring period to date is 15 years. Although the measuring periods have been too short to permit firm comparisons of growth between management systems, the short-term data indicate that the ranges of board-foot growth rates under selection management for three site-capability classes (site index for oak) are about as follows:

Site index	Annual board foot growth per acre
80 (75-84)--excellent	400 to 600
70 (65-74)--good	250 to 400
60 (55-64)--fair	100 to 250

Additional detailed growth information will soon be available from the growing stock level plots.

Tree Growth

Individual tree growth has been studied not only on the Fernow Forest but throughout West Virginia. Two survey-type studies have been made and reported in publications.

One study of yellow-poplar dealt with diameter growth in relationship to tree-vigor class and to tree diameter. Using vigor classes 1, 2, 3, and 4--based largely on crown position and size, in descending order of vigor--10-year diameter was found to be significantly related to vigor class.

The second study dealt with diameter growth of five upland oaks in relationship to vigor classes, to d.b.h. classes, and also to site index. Significant growth differences were found among vigor classes and site-index classes.

Four years ago we established an individual-tree study to learn more in detail about the factors affecting growth in diameter, in total height, and in merchantable height. Periodic measurements are being taken on about 1,200 trees to define how tree size, stand density, crown characteristics, and site quality affect growth. We plan eventually to study all of the major species in the northern Appalachian area.

Hardwood log quality

Improvement in log quality, which translates into improved lumber quality, is a basic requirement for profitable hardwood forest management. The spread in stumpage value among logs of different grades is very wide. As an example, let us consider an 18 inch d.i.b. sugar maple log. In 1962 the Monongahela National Forest stumpage appraisals resulted in a value ratio for such a log of 13:7:1 for log grades 1, 2, and 3 respectively.

Increasingly our research program is placing emphasis on quality studies. Inventories on all compartments and most study plots include estimates of volume by grade class so that the effect of site and treatments on log grade can be appraised. We have sampled hundreds of butt logs by species and as a result have developed some species relationships between butt-log grade and tree size (Fig. 1). A paper will shortly be published on these relationships.

Recently we completed a study of the effect of openings in producing epicormic branches on sawtimber border trees. The three species studied were susceptible to feathering out in the following descending order: northern red oak, black cherry, and yellow-poplar. The published results of this work will soon be available.

One man on our staff, Clay Smith, is preparing a problem analysis of epicormic branching relationships in Appalachian hardwoods to serve as the basis for additional studies in this field.

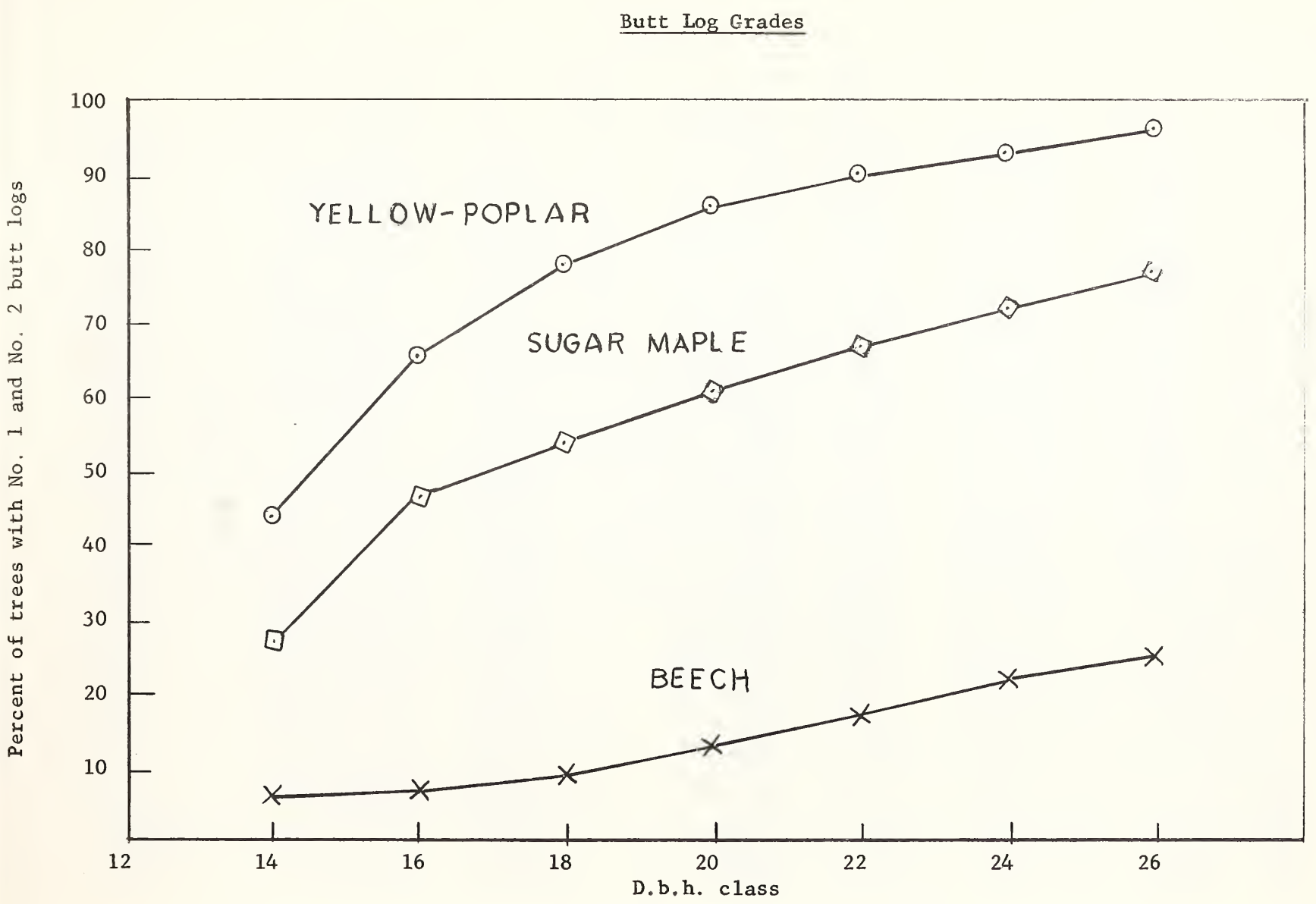


Figure 1.--Relationship of butt-log and tree size

One man on our staff, Clay Smith, is preparing a problem analysis of epicormic branching relationships in Appalachian hardwoods to serve as the basis for additional studies in this field.

Stand Improvement

Stand improvement measures are an integral part of our study of forest management systems. We have been studying cull killing and cull development on our compartments. Recently we have begun to study the costs and effectiveness of weeding, especially on the even-aged management compartments. In general, our testing of cull killing methods is done to provide information applicable to local conditions.

We have one rather comprehensive study of natural cull mortality where, on several hundred cull trees, we are trying to learn how to better determine which culls need treatment and which will die shortly without treatment.

Some results of our stand improvement work have been published.

Species Conversion

It is undoubtedly true that our northern Appalachian forests contained more conifers in the past than they do today. In this general area heavy cutting and fires reduced the area of the spruce type, drastically cut down on the number of white pine on the drier slopes, and decreased the abundance of hemlock in the valleys.

There are indications that, in the case of the spruce and white pine at least, the conifers will grow better and produce more high-quality timber than the hardwoods that have to a large extent replaced them.

To a minor degree we have been and are studying methods of conversion of poor site hardwoods to conifers. In 1954 a small study was established to learn how to identify the sites where white pine should be favored or could profitably be introduced in mixture with the hardwoods. The early results of this study were published in 1961.

Two years ago, in cooperation with the Monongahela National Forest, we initiated a study of aerial seeding white pine on a 64-acre area of poor oak (site index 50). The study involved eight 8-acre plots (Fig. 2).

The seeding was done this spring and results are not yet available.

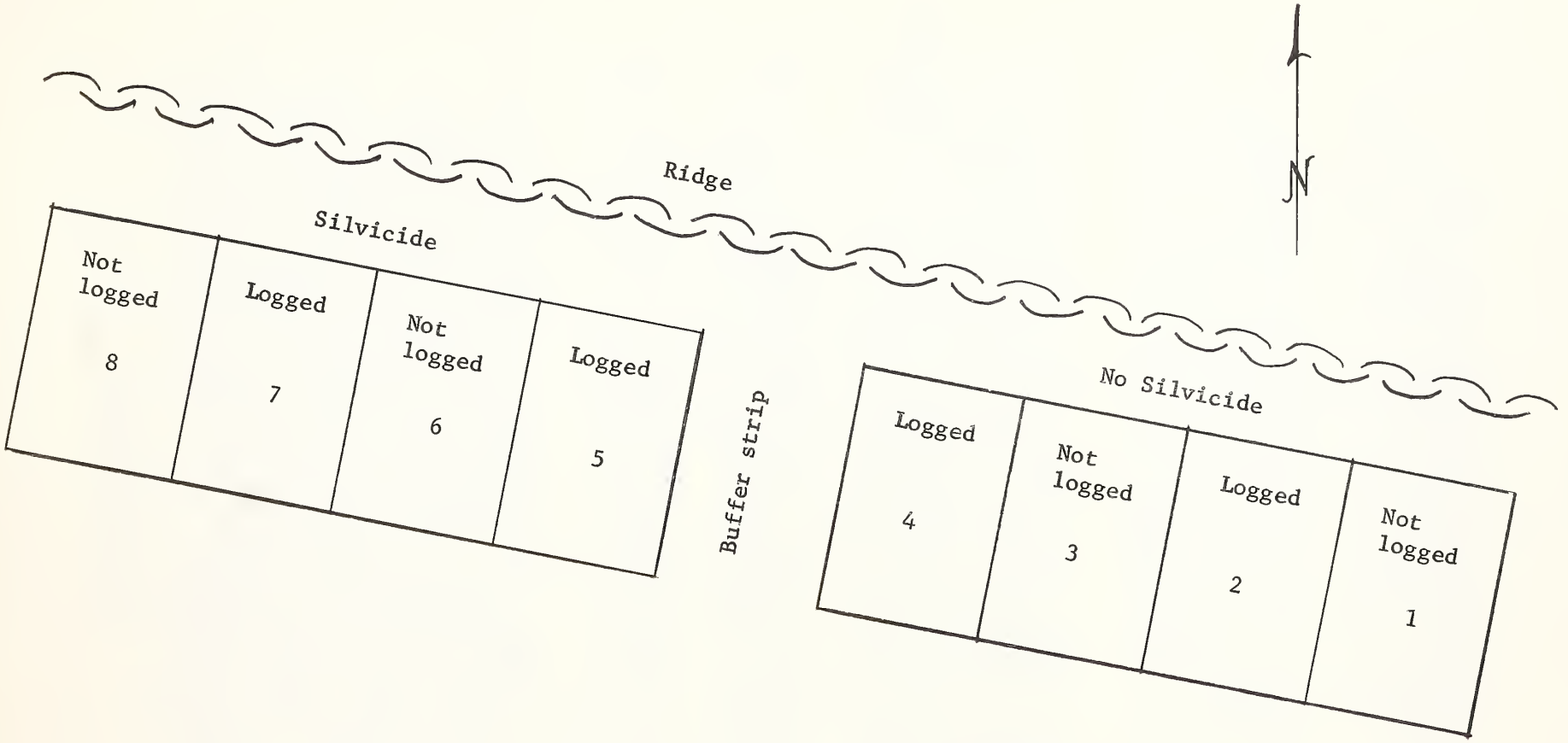


Figure 2.--Study area for converting poor oak site to White Pine by direct seeding

Additional Studies

Other research which has been carried out in the past or is currently active includes: (1) An early study of strip mine revegetation in West Virginia, (2) hybrid poplar clonal studies, (3) growth plot measurements in northern hardwoods and spruce on the National Forest, (4) plot studies of growth and cutting methods near Charleston in cooperation with the Union Carbide-Olefins Company, (5) hybrid poplar testing in a beaver meadow with the State Game people, (6) a study of deer browse on the Fernow compartments with the State Game people, (7) a small thinning study in a white pine plantation on National Forest land, (8) an investigation of the effectiveness of actidione in combating chestnut blight in sprouts of native chestnut, (9) a study of the effect of environmental and individual tree factors on gummosis in black cherry, and (10) an economic study of a management unit.

That ends my report on our local project. Warren Doolittle has asked me to cover very briefly some of the work being done by the Station in northwestern Pennsylvania.

The Allegheny Plateau area in northern Pennsylvania and southern New York is also considered a part of Appalachia, and the Northeastern Station has a small timber management research project operating out of Warren, Pennsylvania.

This project has been conducting research on black cherry and associated species on the plateau for over 30 years. And although much has been accomplished on silvicultural and management problems, I will not have time today to tell you much about it. Instead I will describe in a general way some of the past and present research conducted there. And if you are interested in greater detail, perhaps you can discuss this further with Ted Grisez, project leader from Warren. Ted is with us here at this meeting.

As you know, the Allegheny Plateau of New York and northern Pennsylvania is a highly productive forest region. It is outstanding in the production of valuable black cherry timber which contributes materially to the local economy and the furniture industry as a whole. The proper management of this valuable resource requires detailed silvicultural knowledge of every step in a forest's development from regeneration to harvest.

Because of the existence of millions of acres of young, even-aged stands, a large amount of effort in the past has been put into methods of tending such stands, including weeding, pruning, and thinning. Cutting practices and natural regeneration in second growth stands have received some attention. But, <u>now</u> that a high

proportion of second growth stands are reaching maturity, the problem of regeneration looms more important.

During the past year two major studies were launched at Warren--both of a cooperative nature. The first one is a study of seven hardwood species to determine the effect of tree parameters, weather, and other environmental factors on seed production. Cooperators include several wood-using industries and state and Federal agencies. The second study involves a long term program of research and development of black cherry seed orchards--for the production of superior seed for use in the future regeneration of cherry on cutover lands on the Allegheny National Forest.

Other major research efforts at Warren include:

(1) Methods of handling and storing black cherry seed.

(2) Effect of seed bed treatments on germination of black cherry.

(3) Seeding black cherry in recent regeneration studies.

(4) Natural regeneration of black cherry following clear-cutting.

(5) Relationship of tree vigor to growth and quality for four hardwood species.

(6) Growth and development of 40- to 60-year-old coniferous plantations.

WATERSHED MANAGEMENT RESEARCH IN THE SOUTHERN APPALACHIANS

--THE COWEETA STORY--

Irving C. Reigner
Northeastern Forest Experiment Station,
Forest Service

It must be counted as an honor to be invited here from the piney-woods of Coastal New Jersey to tell you about the oldest and largest group of watershed experiments in Appalachia. Some of us flatlanders yearn for these mountains--others are thankful we don't have to walk uphill.

Before I proceed further, let me point out that two participants in this afternoon's program are graduates of Coweeta. Pete Fletcher, our chairman, and Ed Johnson, my predecessor on this panel, were both members of the Coweeta staff in past years. In addition, Tom McLintock, the Director of the Southeastern Station of which Coweeta is a part, is present and will chair tomorrow's session.

The story of the Coweeta Hydrologic Laboratory begins in 1933, during the days of the CCC. Although the Forest Service has been vitally involved in questions about the effects of forests and forest management on water ever since the passage of the Weeks Law in 1911, this was its first effort at a research program on the subject in the Appalachia region. Information from two pioneering studies, one in Switzerland dating back to 1895 and the old Wagon Wheel Gap study in Colorado, showed that one of man's old convictions was probably not true. Instead of forest cover increasing streamflow, the evidence now pointed toward a conclusion that forests used great quantities of water, more than pasture or farmland, and thereby might reduce streamflow. To study this and other forest and water relationships was the early objective of the Coweeta program.

For the benefit of those of you who have not visited Coweeta, let me give you a short description of the laboratory site. In a word, it is spectacular and you should visit it if you haven't already. Located in the Nantahala Mountains, it is 80 miles southwest of Asheville, North Carolina and only a few miles from Georgia. Its 6,000 acres are steep, ranging from 2,200 to 5,200 feet in elevation, and are well watered. The average rainfall ranges between 70 to 90 inches, about twice as much as we receive in southern New Jersey.

Not only is the topography of Coweeta spectacular, so were the early results of the studies there. For example, several forested watersheds were deliberately abused by bad farming, logging, and grazing practices. The movement of rocks and debris and the change

in timing of streamflow were even greater than expected. This is an old story now, but it showed the value of maintaining a stable soil and vigorous vegetative cover.

The experiments most interesting to me in my field of municipal watershed research were those in which an attempt was made to cause a watershed to yield more streamflow, while at the same time maintaining high water quality. One rather simple procedure was the removal of all vegetation along the stream channel. The aim here was to cut only those trees with their "feet in the water" as they might be expected to be the most extravagant users of water. All woody vegetation was cut to an elevation of 15 feet above the stream channel, amounting to 12 percent of the watershed area. Streamflow after this treatment did, in fact, increase significantly. Daily flows increased 4 to 19 percent with an average for a 10-day period of measurement of 12 percent. I might say, as a sidelight, that one of my municipal cooperators has been removing some of this riparian vegetation for 60 years, although their motive was only partly to increase streamflow. Nevertheless, they had no data to tell them if they increased streamflow or by how much.

Another, more dramatic, experiment was the one in which all the trees on a small watershed were felled but not harvested. As there was no soil disturbance, no changes occurred in water quality or timing, but there was an unmistakable increase of 16 area inches of water yield, a 65-percent gain. Annually, the sprouts and shrubs were cut on this watershed and the changes leveled off to about 11 inches. On another watershed, the effect of cutting produced the same results at first; but here the vegetation was allowed to recover. Gradually, the streamflow resumed its previous pattern. The picture appeared to be complete.

But, as usual, there were complications--research is not that easy, nor the conclusions that clear cut. The increases obtained in the early experiments could not be demonstrated on all small watersheds. There were other variables involved. By the late 1950's it became obvious that more fundamental studies were required, to show more exactly just how these increases in yield were brought about, in order to predict their magnitude. Conversely, we need information to predict which watershed areas will not respond to such manipulation of vegetation. And thus a new phase of the program began at Coweeta to try to answer the questions <u>why</u> instead of <u>what happened</u>.

The real contribution of these early experiments was that they illustrated for the first time on a watershed basis that man does have the power to act constructively, as well as destructively, upon the water resources available to him.

Part of the new program has taken the form of an effort to trace and explain on a physical basis the movement of rainfall from the clouds through the watershed to the stream channel or back to the atmosphere. Far less is known about these headwater processes than is sometimes assumed. One of the directions of this program has led to a study of water movement underground. By measuring drainage from large sloping soil-block models--the latest one is 200 feet long and 7 feet deep--they have concluded that normal streamflow in humid mountain areas is fed primarily by slow drainage from unsaturated soil, rather than from groundwater aquifers. Such an idea alters conventional concepts of groundwater; while not fully evaluated, it appears to be an opportunity to reduce guesswork in predicting flows from small watersheds.

Studies of transpiration make up a great portion of the new program. Physicists have been able to parcel out evapotranspiration losses by means of energy balance calculations. It turns out that under humid conditions only a little more than half the loss of vapor from a forest is transpiration. Evaporation of intercepted moisture makes up a large part of the remainder.

In the attempt to learn more about these physical concepts, studies of heat and energy are under way. The forest is an efficient heat trap--apparently it traps more heat than lesser vegetation and as a result it uses more water. Instruments to measure the net radiation over different types of vegetation will give data related to the amounts of water used by the various cover types. These net radiometers will be mounted on towers or hung from tethered balloons above the forest canopy.

Other studies now in progress at Coweeta have to do with soil moisture and root concentration; getting right down to the individual tree and leaf, plant physiologists are working on ways to cause stomatal closure to reduce transporation. Chemicals have been known to inhibit evaporation; they are now being tried on Coweeta watersheds to see if they will inhibit transpiration, as well.

For this type of research program a team of specialists has been assembled, including a forest hydrologist, a forest climatologist, and a forest soil physicist. The staff has some specialization in many fields: forest engineering, stream biology, mathematics, electronic instrumentation, and geology. New instrumentation is playing a large role in the program. But they have not given up experimental watersheds as a means of applying their findings to management situations, nor have they extracted all there is to learn from rainfall and runoff measurements on small watersheds. The watershed is still the ultimate testing ground. The traditional

large-scale watershed treatment continues at Coweeta, but primarily as pilot tests of ideas which have arisen from previous research.

In 1962, the Coweeta Hydrologic Laboratory received an unexpected opportunity to upgrade its research facilities through the Accelerated Public Works program. Altogether 94 local men were hired for varying periods, adding up to 310 man-months. Much was accomplished; the road system was enlarged and refurbished; a new water system was installed; some of the old CCC buildings were dismantled, others remodeled, and several new buildings were erected. Three experimental watersheds were treated under APW, including the two largest clear-cutting experiments ever carried out anywhere.

The largest single project undertaken during the program was conversion of a 360-acre wild land watershed to a demonstration pilot study of intensive multiple use as it might be applied to municipal watersheds 25 to 50 years hence.

Considering the four primary uses that a municipal watershed may have to provide--water, timber, recreation, and wildlife, the plan is to increase the yields of all four uses to their highest compatible levels. From experience, they will learn which practices tend to conflict with each other. One outcome from the planning was the surprising degree to which management objectives could be made to coincide. For example, clear cutting a compartment served several purposes: it was a timber management tool to reproduce a stand, water yield from the area was increased, and forage was provided for animals. The multiple use demonstration area will be a fine place to bring my municipal cooperators.

Finally, let me pass on a bit of philosophy emanating from Coweeta; it may or may not have originated there. Water, the universal raw material, is the common element that draws together all who are concerned with the conservation of natural resources. A point sometimes overlooked is that good resource management and good water management are often the same, right down to details. Human activities on the land always have some influence on the water resource. Whether the activity is road construction, timber harvesting, grazing, building, camping, or just hunting, the effects will appear eventually in some way in the quality, quantity, or timing of the water flowing from the land. All over the world, it is possible to classify the degree of use or misuse of land by examining the condition of streams, ponds, and lakes below. Conversely, any continuing activity that damages the water resource cannot help but damage the productivity, usefulness, and beauty of the land. Thus we have in water a sensitive indicator of the long-term success or failure of land management.

FOREST HYDROLOGY AND FOREST WATERSHED MANAGEMENT RESEARCH AT THE SCHOOL OF FORESTRY, THE PENNSYLVANIA STATE UNIVERSITY

William E. Sopper
The Pennsylvania State University

Forest watershed management research at The Pennsylvania State University School of Forestry started in 1957 with the establishment of a cooperative project with the Pennsylvania Department of Forests and Waters and the Northeastern Forest Experiment Station, U. S. Forest Service. The purpose of the project is to determine the influence of forest type, condition, and treatment on streamflow from small watersheds in the Ridge and Valley region of Central Pennsylvania.

Within this physiographic province there are two main geologic areas--the sharply-folded, erosion-resistant sandstone ridges and the lower-lying extremely erosive shale hills. The sandstone ridges with elevations up to 2000 feet are almost completely covered with the oak-hickory forest type. The ridges are fairly smooth and the drainage basins are poorly defined. Soils are mostly sandy loams, stony and shallow to moderately deep.

The shale hills have had a greater variety of land uses than the sandstone ridges. Much of the area, formerly farmed or pastured, has been abandoned and now supports old-field stands of virginia pine. Steeper portions have an oak-hickory forest cover. Soils range from sandy to silty loams with considerable amounts of fine rock. Drainage basins are generally well-defined.

Six experimental watersheds ranging in size from 20 acres to 300 acres have been selected for study in the University Stone Valley Experimental Forest. All watersheds are covered with the oak-hickory forest type, with 3 watersheds (Leading Ridge Research Unit) representing the sandstone ridge area and 3 watersheds (Shale Hills Research Unit) representing the lower-lying erosive shale hills area. Stream gaging stations have been constructed on all watersheds and three fully instrumental climatic stations including two groundwater wells have been established. Daily records of streamflow, groundwater, precipitation, air and water temperature, relative humidity, water evaporation, solar radiation, and wind movement are now being secured.

Five years of streamflow and climatic data, representing the calibration period, have been collected on the three Leading Ridge watersheds which were established in 1957 and 1958. These data are currently being analyzed in order to develop prediction equations for use after treatment. If the calibration analysis is satisfactory

the watersheds will probably be treated in the next two years. At the present time specific watershed treatments have not been designated.

Calibration of the three Shale Hills watersheds established in 1961 will continue until 1966. In addition to the studies of streamflow relationships on this Unit, investigations are being conducted to test two experimental weir designs and several types of inexpensive stream gaging stations. The stream gaging station on Watershed 1 consists of a vinyl plastic lined 4.5 H type redwood flume in tandem with a sharp-crested V-notch 60° box weir. Watershed 2 is gaged with a butyl rubber lined weir box with a sharp-crested composite 30°-150° V-notch weir and Watershed 3 is gaged with a vinyl plastic lined weir box with a sharp-crested parabolic notch weir. It is anticipated that the new weir designs will provide very accurate measurements of low flows yet provide the necessary capacity for unexpected high flows. Full-scale models of the weirs were tested in a hydraulics laboratory to study stage-discharge relationships and to develop rating curves.

During the past five years our research efforts have proceeded in two directions: (1) toward detailed studies of the hydrologic processes on the experimental watersheds to determine the influence of the present forest cover on the disposition of precipitation and present precipitation-runoff relationships, and (2) toward the study of basic forest-soil-water relationships.

Along with the usual survey-type studies on the vegetative cover, topography, soils, and geology the following watershed studies were completed:

1. An investigation of the precipitation and streamflow relationships for Leading Ridge Watershed One.

2. Hydrologic analysis of the three Leading Ridge experimental watersheds.

3. A study of rainfall interception by an oak-hickory forest cover on a watershed in Central Pennsylvania.

4. An investigation of snow accumulation and depletion on Leading Ridge Watershed Three.

5. An evaluation of the physical and hydrologic properties of the soil mantle on Leading Ridge Watershed Two.

6. Stage-discharge relationships for a sharp-crested composite weir and a sharp-crested parabolic weir.

Related studies concerning basic forest-soil-water relationships which have been completed included the following:

1. Influence of natural hardwoods and plantation red pine on net precipitation reaching the forest floor.

2. Effects of the forest floor of a red pine plantation on the disposition of summer rainfall.

3. Hydrologic balance of three soils supporting natural hardwood, planted red pine, and old field plant communities in Central Pennsylvania.

4. A study of soil moisture under three red pine spacing plots.

5. The effects of intercepted water on the transpiration rate of red oak seedlings at different levels of soil moisture.

Several studies have only recently been initiated and are still in progress. These include (1) a study of the thermal properties of various types of forest floors, their variation with moisture content and their effect on the energy budget at the soil surface as it relates to evaporation loss during the summer season and freezing and thawing during the winter season; (2) a study of the soil moisture regimes on two experimental watersheds in each Unit to determine seasonal and annual accretion and depletion and soil water storage as it relates to evapotranspiration, groundwater recharge, and streamflow, and to determine the relationship between soil moisture conditions and volume of stormflow; and (3) a study to determine the relationship between soil moisture, groundwater table elevation, and the elevation of emergence of surface flow in the stream channels. Concurrent measurements of the three factors are being made on the main stream channels of two of the Leading Ridge watersheds. It is anticipated that the results of the study will provide some additional information on groundwater-streamflow relationships and contributing area of baseflow.

We have done very little in the area of water quality. Water samples are collected periodically on all 6 watersheds to determine current water quality to provide a bench mark for comparison with post-treatment water samples.

One cooperative project with the Northeastern Forest Experiment Station (Irv Reigner) and Amchem Products, Inc. was conducted to study the control of riparian vegetation with phenoxy herbicides and their effect on streamflow quality.

At many municipal watersheds in the northeast, particularly those employing foresters, streambank and reservoir-shore vegetation is controlled by chemicals. The phenoxy herbicides such as 2,4-D and 2,4,5-T have not been used because water-supply chemists are fearful of contamination since chlorophenol imparts an undesirable odor and medicinal taste to water. On the other hand, the phenoxy herbicides are preferred because they are relatively inexpensive, noncorrosive, and provide better brush control. A considerable amount of information is available on the taste and odor thresholds of the chlorophenols but relatively little is known about the contaminating effects of the phenoxy herbicides. No evidence has been published that these chemicals have contaminated a public water supply nor are there any case histories to the contrary.

Two small streams on the Newark, New Jersey watershed and two streams on the Pennsylvania State University Experimental Forest near State College, Pennsylvania were selected for treatment. A portable mistblower was used to spray one acre of streambank vegetation along one stream with 2,4,5-T in an oil-water emulsion and along the other with an emulsifiable acid herbicide with no oil carrier. Water samples were taken periodically after treatment at various locations up and down stream and tested for contamination by a three member odor panel. Results indicate that during the three weeks following treatment contamination of streamflow occurred only immediately after spraying and after the first large storm. In addition, contamination was detectable only within the treated reach of stream and no contamination was ever found in a downstream sample. Therefore, it appears that phenoxy herbicides can be used to control riparian vegetation on municipal watersheds if properly applied with the normal precautions without constituting a water pollution hazard.

Looking toward the future and the extension and application of research results from small experimental watersheds, a second cooperative study is currently underway with the Northeastern Forest Experiment Station (Howard Lull). The purpose of this study is to investigate streamflow characteristics of small watersheds in the Northeast. Seventeen years of daily streamflow records from 137 small watersheds in the Northeast are being analyzed to obtain information on the variation in annual and seasonal streamflow, flow duration and peak flows, to determine if physiographic regions have distinct regimes of streamflow, to compare average regional water yields with that of experimental watersheds and to develop prediction equations for water yield based upon climatic, edaphic, topographic and land-use variables.

Closely related to our watershed research is a university inter-disciplinary project currently underway to determine the feasibility of disposal of treated sewage effluent on non-aqueous sites.

Efficient sewage treatment plants produce effluents which are low in biochemical oxygen demand but relatively highly enriched in minerals. Such effluents, when loaded into low flow streams, increase biotic activity to such a degree as to make the oxygen supply unfavorable for fish life. In addition, these effluents contain considerable amounts of synthetic detergents (surfactants) which produce unsightly foam. More important, however, is the fact that effluents discharged into natural watercourses are virtually lost where most of the local water supply is obtained from the ground water reservoir. Therefore, it is desirable to know to what extent sewage effluent can be recaptured, utilized, renovated, and recharged to the ground water reservoir thus conserving the water resource of an area and alleviating stream pollution.

A pilot study is being conducted by the Waste Water Renovation and Conservation Research Institute in the Institute of Science and Engineering of the Pennsylvania State University. Treated sewage effluent is being used to irrigate agronomic crops and forested areas.

The forestry phase is aimed at determining to what extent sewage effluent can be renovated for ground water recharge through irrigation of forest stands and to what degree the trees utilize the nutrient elements present in the effluent. Effluent is applied at rates of one inch per week and two inches per week through a rotating sprinkler system to plots in a natural mixed hardwood stand, a red pine plantation, and an open area supporting primarily an old field plant community. Sprinklers are placed on 5-foot risers in the hardwood stand and open area and on 42-foot risers over the canopy of the red pine plantation. Rate of application is 0.25 inch per hour.

Forest floor pans and pan lysimeters are installed to collect percolate samples of the effluent for chemical analysis to determine the extent of renovation occurring in the forest floor organic layers and in the upper 3, 6, and 12 inches of soil. Penetration of the effluent through the upper 20 feet of soil mantle is monitored with a neutron probe.

Diameter and height measurements are being recorded weekly to determine growth responses and foliar samples are collected periodically to determine the degree of utilization of the nutrients applied in the effluent.

Results to date indicate that satisfactory renovation of the sewage effluent was obtained on all plots. The average concentration of constituents (P, K, Ca, Mg, Na, N, Cl) in percolate collected at the 12-inch soil depth was considerably less than the allowable limits for potable water set by the U. S. Public Health

Service. Concentration of the ABS (synthetic detergent constituent) passing the 12-inch soil depth ranged from 0.16 to 0.06 ppm which represented a reduction of 94.7 to 98.0 percent in the average concentration of ABS in the effluent.

This pilot study will continue for two more years with a moderate expansion this year to irrigate a total of 60 acres. This expansion will include both agronomic and forested areas and will also involve a different soil type and geologic condition.

Our research program as one might expect is closely allied with our instructional program and we rely heavily upon graduate student assistance to implement and conduct our research projects. At the present time we have 6 graduate students working on various forest hydrology studies and we hope that we will be able to continue to obtain the necessary resources to increase our graduate student enrollment in this field of specialization and hence to broaden our research program.

FORESTRY RESEARCH--THE FUTURE
TIMBER MANAGEMENT
PARSONS, W. VA.

Warren T Doolittle
Northeastern Forest Experiment Station, Forest Service

INTRODUCTION

One thing that I especially hope has been impressed upon you by now is the subject quality--hardwood timber quality. Yesterday afternoon Dick Trimble and his colleagues informed you of the importance of past and current silviculture and management research in producing high quality hardwood timber To quote Dick, "Improvement in log quality, which translates into improved lumber quality, is a basic requirement for profitable hardwood forest management." As an example of the great differential in value between factory log grades 1, 2, and 3, he showed that 1962 stumpage appraisals on the Monongahela National Forest resulted in a value ratio of 13:7:1 for log grades 1, 2, and 3 eighteen-inch sugar maple logs.

Intensive timber management programs can increase the volume of high quality timber in a stand--through a gradual process of cleaning, pruning, thinning, improvement cutting, harvest cutting, and either natural or artificial regeneration techniques. And as artificial regeneration plays a greater part in management, then tree improvement through the selection of superior trees and the establishment of seed orchards will bring further increases in quality through improved growth, form, pest resistance, or some other facet of timber quality.

It is probably not news to you that at present only about one-third of the volume of sawtimber in West Virginia is of factory log grade 1 and 2 material. And in the sawtimber size material, one-third of the volume does not meet factory log grade specifications at all. Management through good silvicultural practices and protection from fire, insects, and disease could improve this proportion substantially.

To quote from "Appalachia" (A Report by the President's Appalachian Regional Commission, 1964): "At present, timber growth is about double the volume harvested; but because of poor quality stands and heavy losses to fire, disease, and insects, this growth is only a fraction of the potential, and the volume being added is generally low in quality."

In addition to the general statistic that 64 percent of the State of West Virginia is forested and that 89 percent of the

forested lands are now in hardwoods, there is also the fact that probably several hundred thousand acres of low site hardwood lands should be converted to softwood species. For example, the Monongahela National Forest estimates that there are 36,000 acres of such land on the Forest that should be converted to pine or spruce by seeding or planting conversion programs. Most of this conversion is calculated to increase the timber production on these lands, but some conversion, especially in the high mountain areas, would be largely for aesthetic and watershed purposes. Also the Monongahela Forest estimates that about 240,000 acres of hardwood forests need to be regenerated to hardwoods--because of the present poor condition and stocking of these stands.

With this background of emphasis on hardwood timber--and I am optimistic enough to believe that we will have a market for all of the high quality wood we can produce in the future--I will now turn to the more specific part of my subject today--the future timber management research program at Parsons.

PARSONS RESEARCH PROGRAM

Briefly and in a general way, here is what the current and future program at Parsons is trying to achieve. Our program is largely biologically oriented, but we are studying the broader management aspects too. We feel that our major job for the future will be to devise silvicultural and management treatments and systems which will result in increases in volume and quality--to effect these increases in terms of maximum profit. And to accomplish this job we must measure quantitatively tree and stand response to treatments, assign a value to the response, determine going cost rates for such treatments in practice as soon as it is feasible, determine if the treatment is profitable--especially when compared to other methods for the same treatment and when included with a series of other cultural measures, and finally present the results of this research to forest land managers.

Of course there will be a lot of research (some fundamental) that will not contribute directly to answering management problems. Yet without this research, we may not have the understanding and tools to effectively go about solving the more obvious problems or needs. For example, much of our soils and site work falls into this category.

COMPARTMENT STUDIES

We have special studies on some problems at Parsons, and we also have a unique set of compartments there which very few forest research units have anywhere today. These compartments, which Dick Trimble described to you yesterday, are set up on a long-term basis

with specific silvicultural systems and cultural treatments assigned to cover the range of sites and species in northern Appalachian hardwoods. We are trying to find out the long-term effect of a program of systems and treatments. More than that we are measuring carefully the differential responses of the land and stand to the several systems and treatments involved.

Certainly we have been and we will continue getting short-term results from treatments on these compartments and from studies on other areas off the compartments and off the Fernow forest. But, I would like to emphasize that if we do not follow these specific systems of treatments over a long period (rotation or more) of time, we may find that although certain short-term study results appear to be desirable (or undesirable), the long-term effects may be entirely different.

I have heard some researchers and forest managers say that long-term compartment studies in research are not needed, that sufficient information of this type will be obtained from national, state, and industry forest lands. However, nowhere have I seen the careful, detailed, long-term records of sites, stands, and treatment response necessary over a long period of time to know what the response really is and exactly how much.

At one time, Northeastern Station had numerous sets of compartment studies all over the Northeast--with considerable overlapping of species and treatments, but today we have only three sets well distributed across the Northeast--in Appalachian hardwoods (West Virginia), in northern hardwoods (New Hampshire), and in spruce-fir (Maine).

All of these large scale studies are coordinated and conducted cooperatively with the Division of Forest Economics Research, and the one at Parsons is in close cooperation with both Watershed Management Research and Forest Economics Research.

OTHER STUDIES

The large scale compartment studies at Parsons will continue to be a major research effort in the future, and there are five other problem areas which will require major research effort. Most of the studies in these five areas will support and extend the results from the compartment studies, but many will also be useful directly to the forest manager.

Some of this research will require intensive, fundamental studies in physiology, soils, and silvics. And it is indeed timely that the new laboratory at Parsons is now ready to backstop these needs.

Soil-Site

Studies relating site productivity of the land to soil and topographic features have been conducted for 10 or more years by the Parsons' research project. The mapping and interpretation of forest soils by the SCS and the National Forest Surveyors during this period have greatly increased our knowledge of land productivity, but there are many parts of this problem which need careful study to determine why and how certain soils respond or react as they do to treatment or in showing productivity. For example, the Upshur and related forest soil types will require special site studies in order to better understand these soils and to facilitate the development of additional relationships necessary in predicting forest productivity and perhaps in effecting a further, improved classification of the Upshur soils group.

The Ashby soil is another example where productivity is variable and not well understood. It is felt that a greater knowledge of the nutrient status of this soil would vastly improve our current limited knowledge of why and how these soils produce or respond as they do.

Another area of soils research which we plan to investigate is in the variation in productivity within and between soil types of the northern Appalachians.

Much of this new work will require special studies of physical and chemical properties of these soils in which the facilities of the laboratory will be utilized.

Regeneration

During the life of a timber stand there are several opportunities or stages where a cultural treatment can effectively improve the quality and value of the later stand. However, there is probably no time as effective as during the period of regeneration and immediately thereafter. For it is here that the most valuable species and high quality stems can be established and can gain crop tree positions in the new stands.

New regeneration research at Parsons will include an extension of the present studies in both even and unevenaged stands. However, emphasis will be on studies in evenaged silvicultural systems--clearcutting, shelterwood, seed tree, and patch or group selection. Here we need to tie down more closely a recognition of the conditions of the stand and soils and the treatment of seedbed and low vegetation necessary to get desired species established quickly and completely by means of natural regeneration. Further, our research must develop a method of being able to detect failure of natural regeneration at an early stage--say in 2 years or less. Or, it may

be determined that natural regeneration is not likely at the very beginning. In either case, artificial regeneration is in order, and effective site preparation and seeding or planting must be initiated. Here again we need more new research to refine the techniques to be applied on the numerous combinations of sites, species, and weather.

Earlier I talked briefly about the big conversion job in West Virginia. This is artificial regeneration, and ties right into many of the same problems just described for forest land where the forest has been harvested and we are trying to get the same or similar species back. One difference is that we are trying to get hardwoods back on the one hand; whereas in conversion, the species being regenerated are usually coniferous.

Tree Improvement

Once we have taken one step (artificial regeneration) into intensive management of the forest, it is almost impossible to stop a chain-like series of such cultural treatments. Logically, if a land manager is going to go to the expense of artificial regeneration, he should take the next step and utilize the best seed or seedlings--in the genetic sense. This is the point where we stand today in Appalachia, with the beginning of seed production areas, plus tree selections, establishment of seed orchards, and tree breeding programs.

Recently Northeastern Station and Region 7 of the Forest Service launched a plus-tree selection and seed orchard program in black cherry on the Allegheny National Forest. This type of program is probably a first on this scale in hardwoods, and there are a number of silvic and genetic problems anticipated for research as well as a golden opportunity to conduct large scale studies of genetic and tree improvement phases such as seedling versus clonal seed orchards.

And in the near future, we hope to participate in a similar program in white pine on the Monongahela National Forest. Here the major use for an improved white pine would be in the conversion of low quality hardwood stands--and the genetic improvement would be mainly for growth and form. Also in the future we anticipate additional tree improvement programs in hardwoods and we plan to participate in these programs and conduct research on the attendant problems.

Many of the research problems associated with these tree improvement programs will require special studies which will be conducted in the nursery and laboratory--especially on flowers, seeds, seedlings, and propagation.

Stand Improvement

The continued improvement of forest stands--that have progressed in quality through regeneration and genetic efforts--will be increasingly important in the future and will be implemented by early release, weeding, thinning, and pruning. Most of the studies on stand improvement will be or are being conducted as a part of the compartment studies--or as superimposed studies on the compartments.

However, special technique and response studies will have to be conducted separately, too. This will be especially true of early release and early weeding problems. For example, we usually recommend the first weeding in young hardwood stands at no earlier than about 10 years of age; but, we now suspect that in so doing we sometimes lose a large proportion of the best species and well formed stems--especially where intolerant species are involved. Perhaps there is a need here to examine newly regenerated stands during the first 2 or 3 years and be ready to perform an early release or cleaning or both. The establishment of criteria in determining the need for treatment is a major problem in itself. So here is another important problem at a very critical period in the life of the stand which needs attention. And there are others associated with later thinnings (spacing) and pruning (quality).

In addition to the special emphasis on future stand improvement research in seedling and sapling stands, more conventional studies will also continue in existing pole and young sawtimber stands which are so abundant in the northern Appalachians. These are the stands that require conditioning by thinnings and improvement cuttings.

Growth and Quality

Current studies of stand and individual tree volume and quality increment will be extended in the future to include increasingly sophisticated techniques of relating this increment to stand and environmental factors. And since the mensurational techniques and electronic computer analysis procedures being developed by other researchers in other places may be applicable in West Virginia, it is extremely important that this work be carefully coordinated so as not to result in duplication or wasted effort.

Our stands are mostly of hardwood species, and more and more we realize the need to study both volume and quality increment at the same time--to learn what effects environment, stand, and cultural treatments have on these two elements of increment.

Part of the answers learned in the growth or increment studies described above will be used with log and tree grades and tree vigor information to produce economic maturity guides for the Northern Appalachians. This is a cooperative program with Forest Economics Research and it also includes similar arrangements with other Timber Management Research projects in the Allegheny hardwoods and the true northern hardwood types in New Hampshire.

CONCLUSIONS

In my concluding remarks I would like to emphasize that our research program at Parsons is not operating in a vacuum. We are biologically-oriented to be sure, but we also understand the importance of the business management or economic aspects of timber management, and the need for coordinating timber management with the other forest land uses--wildlife, recreation, and water.

We know that silvicultural systems are often influenced by logging or other management decisions. Take the case of logging, for example; because of the hard labor involved and the going wage rate, it is becoming increasingly difficult to find woods workers. This means getting more mechanization in the woods operations which in turn may affect harvest cutting practices to the extent of changing silvicultural systems from selection to evenaged. It is not quite that simple, but I believe you can see what I mean. Fortunately, silviculture and management are flexible and can be moulded and changed, within limits; this is a part of the job of research.

On the side of management, as I mentioned earlier, we have plans for getting out economic maturity guides for northern Appalachian hardwoods; we have plans for cost and return information on a 600-acre management unit on the Fernow Forest and also periodically on the compartments and woodlots on the forest; and during the next 2 years we have plans to publish a comprehensive summary bulletin on the silviculture and management of northern Appalachian hardwoods. These results will require the participation, cooperation, and coordination of two or more projects in Timber Management Research and the Division of Forest Economics Research.

And I would like to recognize the excellent cooperation we have in research with the universities, particularly West Virginia University and the Pennsylvania State University--and although Virginia Polytechnic Institute is outside our region somewhat, we hope to continue to expand our cooperation with them, too. These relationships assure us that we are conducting the right kinds of

research; it means that through cooperation we can be assured of full utilization of all available talents and facilities; and it helps in avoiding unnecessary duplication, yet providing for several approaches and replications on certain research studies. And finally, much of our research could not be accomplished without the direct and indirect assistance and backing by state and Federal agencies and by the wood-using industries.

COMMUNICATIONS BETWEEN RESEARCH AND PRACTICE

Howard P. Berthy
Extension Service
West Virginia University

When you learn of a "gyppo" sawmill operator, with a long history of "clear-cut and get-out", who has unexpectedly emerged as a strong believer in and practitioner of modern silviculture and forest harvesting techniques, do you ever wonder how this transformation came about? Chances are he is the victim of an effective program of communications. Chances are these changes resulted from not just one or two communications alternatives, but from a gradual metamorphosis of many stages. Most commonly these stages are identified as, the awareness stage, the interest stage, the evaluation stage, the trial stage, and the adoption stage. It is not likely that reading a bulletin, attending a meeting, or making a single trip to an Experimental Forest (such as the Fernow) would bring about changes. First of all, something must create an awareness that there is a better way of doing things. After visiting a demonstration area this operator might go somewhere else for additional information to satisfy his interest. He then evaluates the new idea as he saw it in practice and elects to give it a try. After the trial, he must finally accept or reject the idea.

When you are aware of such changes coming about, do you ever wonder what techniques were used to reach this man. He was undoubtedly hit by one or more shotgun blasts from mass media that created his awareness. Then gradually, he moved to become the final practitioner we seek. What causes the normal client to act? What motivates him? It must be something close to where he lives.

Occasionally, as I drive down the highways of West Virginia, I have the dreadful feeling that, from the standpoint of forest management, we are losing ground rather than gaining. When I see woodlands that I have been keeping an eye on over the past fifteen years give way to clear cutting and slashing; it occurs to me that possibly loggers and sawmill operators are better salesmen than professional foresters. I deaden the pain a little bit by recognizing that the professional forester interested in improving harvesting practices, is badly outnumbered and that the logger or sawmill man has on his side a secret weapon. It is that rare commodity called M-O-N-E-Y -- something with which those of us in research and education are often not familiar. We also find ourselves putting the landowner in a nervous bind by attempting to overcome his natural resistance to change. Yesterday, Ed Matics pointed out that timber stands which have been marked and harvested according to good forestry standards are all too often subjected to clear cutting at a later date. In such cases, the professional forester brought about a desired change in the landowner. The landowner tried something new. The basic problem is that while we succeeded in getting him to do something new, we failed to urge him to quit doing something else. Our communications job was not complete.

What is communications? It is defined briefly as the distribution of information. A review of literature reveals that one naive soul identified it as the relatively simple task of disseminating information through news, television, radio, demonstrations, tours, individual contacts, correspondence, group meetings, and exhibits. A person whom I consider a realist, identified communications as the hazardous, complex, expensive, and highly competitive business of changing attitudes to bring about desired results. I would say that communications in Extension is the act of providing, through personal methods, group methods, or mass media, information necessary to identify alternative courses of action for bringing about desired changes. The selection of the course is left to the individual or group client. It is a confusing job at best. Communications has three basic stages: (1) Getting new knowledge, (2) Interpreting the knowledge so that the specific client systems can understand it, and then, (3) Transmitting the knowledge to the client system in a manner that is interesting and appealing.

The methods used to perform the communications job must vary according to the type of information to be disseminated, the client systems to be reached, and the availability of capable personnel to do the job. The successful communicator must have a thorough understanding of media and methods, a deep expertise in subject matter, a thorough knowledge of the target client system, and the patience of Job. He must accept gradual changes. It is essential for the effective change agent to be willing to wait for evolution.

Grant that the communicator has subject matter knowledge, let us turn to the selection of the media. The communicator must know what method will do the job. Different client systems react differently to the various media. Some methods are more effective than others. A Federal Extension study of more than 15,000 farms in 27 states indicated that 19 percent of all adopted practices were the result of indirect influences. That is, talking over the fence. Or as one sociological study said, "Talking to the Elmers". The Elmers were the early adopters. This is called "spread of practice". The next most effective method was discovered to be demonstrations and meetings for 18 percent; followed by general meetings--15 percent; farm visits--11 percent; mass media--10 percent; and bulletins--8 percent. The least effective was the exhibit. It was less than one percent.

Considering the cost per unit in practices adopted, it was found that news articles and radio were the least expensive; next were circular letters, office calls, general meetings, publications, farm or home visits, and demonstrations. Exhibits were the most expensive and the least effective method.

Let us consider our client--the forest landowner. In the five states represented here, forest landowners number more than 900,000 owning almost 48,000,000 acres of forest land. How do we make forest practitioners of these thousands of landowners? Before the landowner can regard his woodlot as an integral part of his farming operation,

he needs knowledge of certain aspects of forestry. His lack of knowledge is basic to the total forestry program. The woodland owner, all too often, is unfamiliar with the techniques of harvesting a forest crop. He has neither the equipment nor the experience to effectively do the job. He is unfamiliar with timber products. He therefore is unfamiliar with the methods of measuring, grading and marketing these timber products. We might ask--if the landowner has 50, 100, or 500 acres of land, why isn't he better informed on these subjects?

Here are three factors that tend to influence this situation:

(1) The small size of the operation permits only a relatively small production of forest crops. This does not allow the landowner to be competitive in marketing his products.

(2) The owner's interests and skills are not related to woods work, therefore, he gives this work a low priority, and, in many respects due to the first two factors,

(3) The low returns per unit of production, per unit of area, and per unit of labor leads to total neglect of the woodlot by the owner. In the long run this puts him in an even poorer position with respect to markets.

If these landowners are to overcome influences which tend to prohibit their being effective forest land managers, numerous educational programs must be developed, expanded, and communicated to the landowners. The following list of educational activities needed to bring about desired changes has been identified by Extension Foresters in the Appalachian States.

(1) Intensify educational work to acquaint forest landowners with opportunities, with management practices, with A.S.C. cost sharing provisions, and with other assistance available through public agencies.

(2) Encourage landowners with suitable situations to take advantage of the multiple-use aspects of forest resources, including camping and other recreational enterprises.

(3) Instruct landowners in techniques for dealing with the economics of woods work, enterprise records, and business management.

(4) Provide training programs for forestry and logging workers, and the unemployed, at established training centers or other suitable locations. Where conditions warrant, these training programs should be conducted with the cooperation of wood-using industries.

(5) Establish landowner associations or corporations for cooperative forest management and marketing activities. Other arrangements such as long-term lease arrangements for the same purposes should be studied to determine their feasibility under specific conditions. One alternative might be timber pooling by small forest owners to place these small owners in a better position to compete for markets. This is an allied approach to land pooling.

(6) Familiarize logging contractors with forest management practices and with modern equipment for logging in mountainous terrain. Well trained and properly equipped logging crews can be the key to getting desired practices put to work.

(7) Assist area planning and development groups by providing forest resource data and processing information for planning and developing new industries and expanding existing industries.

These are but a few ideas for developing stronger action programs in forest land management. The communicators--extension specialists and others, are already putting many of these ideas to work. Professional personnel charged with the direct responsibility of carrying out such programs are few in number. It is not too unusual to have in a state 25 professionals in service work, 100 professionals in research, and one professional responsible for communicating new subject matter knowledge to the people. A representative of an advertising firm has said, "all foundations are making two mistakes in policy. First, they spend most of their money on the increase of knowledge and very little on the distribution of it. Second, when they do spend money on the distribution of knowledge, they use old fashioned horse-and-buggy methods---." Naturally he was grinding his own axe. Naturally I am too.

Even with an increased number of communicators the job cannot be done by them alone. They must have the wholehearted interest and support of highly competent researchers.

In conclusion, I submit for consideration by researchers the following thoughts which could help bridge the gap from research to practice.

(1) There is a need for more applied research. Period. No further comment.

(2) Consider communications factors as research projects are designed and executed. Will research sell? Who will buy it? What can be done to make it more attractive?

(3) The assistance of researchers is needed to design, set up, and maintain demonstration areas.

(4) Researchers can help communicators by calling attention to research that is particularly suited for use with landowners. A regular rating or evaluation by the researchers would help the communicator identify worthwhile research that might otherwise get lost in the millennium of material that comes to the communicator's desk. One large step in this direction is the practice recently developed by the Forest Service of having printed catalogue cards for each publication issued.

(5) Researchers should occasionally review past research projects. Has this research been put to work? If not, why not?

(6) When possible build in more economic evaluation, even prior to starting a research project. This is the communicator's ammunition to hit the forest landowner where he lives.

As you consider the above recommendations, ask yourself how your research can be put to work. Ask yourself how your research competes with other materials--other knowledge, that is continuously entering into the communications stream. Is there something about this work that literally stands up and demands to be put to use or does it land on the communicator's desk with a dull thud, leaving him with the task of deciding what to do with it. Will he (1) toss it away because he doesn't have much storage space, (2) file it away for possible future use or disposal, or (3) decide to put it to use immediately in developing educational communications programs?

Research and communications must be a closely knit partnership. The communicator or more specifically the Extension Specialist, must rely on assistance from researchers if he is to effectively identify and use available knowledge to bridge the gap between research and practice.

COMMUNICATIONS BETWEEN THE RESEARCHER AND THE FOREST LAND MANAGER

William W. Wentz
Region 7, Forest Service

How can management avail itself of research results and stimulate the movement of them into management practice?

When I was assigned this topic to discuss--I did what seems to be popular in an election year--I ran an opinion survey. Suggestions were solicited from a number of land management folks so I could better present this topic from a broader base of experience. I received splendid response and the remarkable thing was the nearly complete similarity in the replies. Whether they ranged from the half page longhand note to the three page reply, they all boiled down to two basic ideas:

1. Personal communication.
2. Studies and applied research.

We are all in agreement that the management-research team is still made up of people and that talking face to face as we are today can provide the needed opportunity to stimulate better coordination of the research results with the management job.

It appears from the National Forest standpoint that close cooperation in the analysis of research needs is possible at sub-regional or ground level. Workshops and meetings similar to this will encourage the managers to acquaint the researchers with problem areas. Free and easy lines of communication must be maintained between field and projects on a two-way basis. All of us recognize that there are many more problems to be solved than we can expect to reach with current staffing. In this respect, perhaps the personal involvement of the management group can extend the range of the research effort.

What I have in mind is working like this:

On the Allegheny we are fortunate in having the Forest Recreation and Wildlife Laboratory near Warren. Dr. Ward Sharp of the Fish and Wildlife Service and Dr. Jim Jordan of the Station are working on habitat and animal studies involving small game and upland birds. They had some typical habitat needs in mind to carry out these studies. The rangers on all districts are actively engaged in compartment examination and were able to locate compartments closely resembling the habitat desired. Working with the forest biologist and with guidance from Dr. Sharp

and Dr. Jordan, the lacking habitat features were created through regular National Forest programs (i.e., small timber sale and scheduled cover planting).

In this case history, the management group became personally involved. They are proud of their participation and eagerly await results. When these research results are available, I don't think we'll have much of a problem stimulating their movement into management practice.

Admittedly, this is a single project but not isolated. Right now, every forester, aid, and technician involved in sale preparation, TSI, compartment examination, or other woods activity on the Allegheny, is searching for superior black cherry specimens. I'm sure each one is convinced that he will find more of the best trees on his district. They are personally involved in the tree improvement project and will, by force of numbers, help accomplish the job quicker than a single scientist could do.

Working together on projects of mutual interest will surely foster closer ties and better understanding of problem areas.

On projects that do not lend themselves to this approach--frequent trips to nearby experimental forests or demonstrations will keep the management group aware of research progress.

All in all, this improvement in personal communication should create a climate where the research results will be readily accepted and applied when available.

On the other side of the coin, there are frequent problems facing the land manager for which final research results are not available. In many cases the answers are years away and the manager just can't wait.

Here is where I feel that another opportunity presents itself. We recognize that interim, inconclusive research results cannot be published. But here within the Forest Service family, I feel that we should have good enough communications established that joint understanding is possible. Many times the land manager makes decisions without all the possible facts. In many cases, partial information, properly evaluated, can help in making decisions that at least head in the right direction. We have all heard well qualified scientists say, "I don't have the basic facts documented--but on the basis of my observations and experience, I am satisfied that this may be the answer." In some cases, this may tip the scales in the proper direction.

Of course, sometimes even this help is not available and the need for a limited applied study is necessary. Here the scientist

can be of immeasurable help to the manager by pitching in his knowledge of project design and techniques of evaluation. Once properly designed and conceived, these studies may be correlated with true research projects to broaden their base.

As I said in the beginning, these are not new ideas but they do not seem to be in common practice in some areas. Basically, they add up to:

1. People to people communication.

2. Mutual aid society and understanding.

COMMUNICATIONS: BETWEEN RESEARCH AND PRACTICE
--THE RESEARCH RESPONSIBILITY--

Sidney Weitzman
Lake States Forest Experiment Station, Forest Service

The previous speakers have given you some excellent background and indicated opportunities for getting results into practice--for communicating ideas. It is obvious that a wide spectrum of techniques can be used and are being used to meet this objective.

As far as the role of research is concerned, I think we can agree on two things at the outset:

1. That communications between the research producer and the consumer (other scientists, extension specialists, the practicing forester, and all land managers) are necessary and desirable. The question is not whether we need it, but, rather, how to do the job most efficiently and effectively. The question is not whether we will do the job, but, rather, what does it take--and what are the essential ingredients for a successful exchange of ideas and information?

2. I think we can also agree that here in West Virginia, at this research installation, there has been a very successful program for the exchange of information between and among all agencies and individuals.

Many Techniques Used

How were these things accomplished? In several ways. As I recall from my personal experience here, the research men have used many different types of media for disseminating their research results. I'll mention some:

1. Publications. The record of research publications for this field unit is excellent. This includes not only technical articles which appear in scientific journals, but more popular articles which have appeared in conservation magazines and trade journals to reach a broader audience.

2. Show-me trips. Here, on-the-ground discussions of research practices and results are carried on. These show-me trips are tailored to the specific audience. They have had show-me trips for civic clubs, professional societies, foresters, engineers, watershed technicians, loggers, etc.

3. Outdoor classrooms. Research results and practices are made available to university students who are brought here by their faculty members to view and consider new and untried practices as well as to bring themselves up to date on latest research results. This unit is a major training facility for foreign visitors.

4. Training sessions. The staff on the Fernow Experimental Forest has had specialized training schools on road layout and design, silviculture, management, log grading, and watershed management practices that range from a few days to a week.

5. Technical meetings. This research facility has hosted several professional and technical groups within the State and the adjoining States. Again, this provides an opportunity to discuss and disseminate research results.

6. Frequent visits. In addition to the research staff acting as hosts for various groups, individual members are invited to visit both public and private lands to see how their research results fit other conditions. This is another way of exchanging information. This matter of exchanging information is a two-way street. Research cannot and should not be undertaken in a vacuum. It has been my experience that the research man benefits by facing the practicable problems of the land manager and discussing them with him.

The research man often finds that there are three stages from discovery to actual application: (1) The first one is "It can't be done," (2) the second is "You can do it here on your experimental area but it won't work for me," (3) and finally "It can be done--it works."

This is the reason I emphasize communications between the land manager and the researcher. It isn't enough for the research man to make the discoveries to his own satisfaction. Not until it has been tried and accepted on an operational basis has real progress been made.

Now I recognize that these activities take some time away from the research doers. Where the working relationships between our extension people, the universities, and industries are excellent (as they are here), it is my experience that these groups can and have assumed a great part of the job. Nevertheless, we must recognize that some people prefer to discuss the situation with the individual scientist who is doing research. This is understandable. Thus, there will always be some demand on the research man's time.

When some of our busy research men complain to me that they are too busy to undertake this job of informing people, I have a standard reply. I tell them the time to complain is not when people

take up too much of their time, but, rather, when people stop coming--because then they have nothing new to offer.

Communications is More Than Techniques

You gather from what I have said that I feel our scientists in Parsons and Elkins are getting fine acceptance of the research results. The question of communication between the researcher and the land manager, however, is of general concern, otherwise we wouldn't be discussing it.

I believe that the reason my colleagues in West Virginia have been so successful is because of other features than just good communications techniques. One feature is hard to describe. This feature goes beyond publications, show-me trips, training sessions, close contact with universities, the Extension Service, etc. This is an intangible ingredient--it is "attitude." It is their feeling that producing research information alone is only part of the answer. Getting it into the hands of the producer is the other part. This perhaps above all is the one ingredient that we need to instill our people with--the desire to share their information. With that desire, they will have ways and means of getting the job done.

Perhaps, then, the answer to getting communications has several facets, such as:

1. A strong desire and recognition by the research man to communicate. He must recognize that this is an integral part of the total effort. He must want to share it.

3. Using all the obvious techniques such as publications, show-me trips, training sessions, meetings, etc., is a second part of the answer. By itself, this is not enough. Yet too many consider this the total communications effort.

3. And, finally, perhaps we just need to produce a better product, build a better mousetrap, and produce research results that the public will want to beat a path to our door. All research is not of equal quality; all research answers are not equally valid--just as commercial products do not share the same high reputation and acceptance. So perhaps the communication problem is not a failure of communication per se, but, rather, (1) having something worthwhile to communicate and (2) the strong desire to reach the public.

Therefore, I offer this three-pronged approach, of which communications is only one aspect:

1. A good attitude--the desire to get this information out to all who can use it.

2. A good communications system--use of all communication media whether they be publications, field trips, or any of the others I mentioned above.

3. A good product--something really worthwhile to say and of real value to the land manager.

SUMMARY OF THE TECHNICAL MEETING

Clark E. Holscher
Forest Service, Washington, D. C.

This technical meeting was made up of 19 formal presentations plus discussion. Consideration was given to the following four subjects:

1. Forest land management problems in Appalachia.

2. The need for research in timber and watershed management.

3. The present status of research on timber and watershed problems.

4. The future plans for research in timber and watershed management at Parsons, West Virginia.

Problems

The first three speakers, covering the general multiple-use problems of forest management in Appalachia, were unanimous in their expression that problems of people, that is, the social and economic problems of the region, were most critical and that forest land management must be fitted into these problems to be successful. Realization that forest products is not the sole aim of forest management was evident.

The attitudes of people was considered as a problem in this region, partially because of the ownership situation (70 percent of the forest land in Appalachia is in ownerships of 50 acres or less) and the failure of forest landowners to recognize the forest as a unit for permanent management and profit.

Heavy emphasis was given to recreation as a land management problem, but largely in the sense of achieving a balance of uses, of resolving conflicts and of meeting the needs of the people. This was tied to the changes which are constantly taking place in the uses and demands upon forest lands.

Mr. Wible, in his review of problems of State forest land management, gave consideration to watershed protection and indicated by chart that every acre of the Pennsylvania State Forests had watershed protection value. This is indeed true, yet none of the first three speakers gave recognition to water as a manageable resource. This is in spite of the fact that, nationwide, 70 percent of the total precipitation is lost through evapotranspiration processes, and in the Northeast this might run as high as 60 percent. Also, there was no direct reference in the presentation of problems

to the role of the forest in flood reduction.

Access roads was brought out as a problem of management of timber operations, perhaps not as one for research, but rather one of accomplishment. However, there are a number of watershed problems connected with road location and construction that deserve research attention. Ed Johnson brought out this fact later in the program in connection with his discussion of coal haul roads. Also mentioned in connection with land use and watershed protection was the need for development of better harvesting methods and equipment.

Glenn Smith pointed to the high degree of specialization required in forest management these days and that landowners, land managers, and staff people each require somewhat different kinds of information because of the different jobs they have to do. Smith made reference to four classes of owners, large public, large private, small private for profit, and small private for other; and he implied that these require different research approaches and separate publications. The summarizer agreed that the four classes of owners do have different management problems, but argued that the same research results can often be used by all four classes and that management can be accomplished by fitting the pieces of research results together in different ways.

Smith, in discussing what Timber Management needs from Research, emphasized economics and pointed to a dearth of input data for making economic analyses. Others added that because of the long-term nature of forestry, there is also a dearth of output data--the results of management in terms of growth, yield, and quality. The need for silvicultural research was stressed and because of the many species, soils and climates, emphasis was given to the need for more basic research. Research in tree improvement was included among Smith's list of problems, particularly tree genetics research. In a less technical area, he urged more research in organization for forest management and in better methods of programming timber production operations.

Gil Varney, speaking on the subject of what Watershed Management needs from Research, pointed out the need for developing an inventory of water resources under the many types of land use, the several types of land ownership, and the great variation in soil, climate, and cover conditions. The need for techniques for making such an inventory was emphasized. Varney concluded that the total annual water supply in Appalachia is adequate but that because the range from high flows to low flows is great, the real problems are to reduce excess flows and to increase the low flows. Varney stressed the need for studies of hydrologic processes which can be blended into solutions of watershed problems.

He brought out other problems such as improvement of water quality through watershed rehabilitation and the use of forestry and engineering practices which will prevent watershed damage. He, too, raised questions of economics, particularly as related to water resources, such as, what is water worth, and who will pay for the water produced on forest lands?

Research

After the presentations of the two research panels, there was little doubt that there had been and is being accomplished a lot of good research in both timber management and watershed management. Rather than summarizing all of this, it seems better to try to tie back to the problems presented earlier in the meeting and see how well the needs are being met by Research.

Although the technical program for this meeting was intended to consider timber and water problems, the subject of economics was raised as a problem so often that it deserves some comment and considerable thought. It is surprising that there is so much concern about production economics and so little research going on. There may be some historical reasons for this, so far as agriculture is concerned; but, outside of the area of marketing, there doesn't seem to be much support or much pressure for this kind of research. This is a point for the participants of this meeting to consider carefully.

The first two speakers on the program had a good deal to say about recreation as a forest land management problem. And it seems appropriate to say that there is a pitifully small amount of outdoor recreation research going on. Yet it appears that recreation is one of the great potentials for economic advancement in Appalachia.

Development of better harvesting methods and equipment is an area of research that has long been neglected and is just now getting underway in the Forest Service. There is no research of this kind at the present time applying directly to Appalachia. The report of watershed management research at Parsons by Reinhart stressed the importance of careful road location and construction of logging roads and access roads. There have been studies at Coweeta and in New Hampshire on road location and design for watershed protection. Also, considerable work has also been done in the West which would apply to Appalachia, at least in principle.

Considerable emphasis is being given by research to natural regeneration of desirable species. This seems to be pointing toward an even-aged type of management and in the southern Appalachians, at least, fairly large clear-cut blocks seem necessary to keep ahead of deer damage to reproduction. In discussion, it was

pointed out that more stress should be put on artificial regeneration because of the probability of developing genetically improved strains with seed available only from seed orchards. Tree improvement is getting considerable attention, both in tree breeding programs and through silvicultural techniques. In some instances, soil-site studies are being tied to tree improvement because of the different site requirements of different tree species. Superior planting stock is needed in some cases for regenerating old fields, as well as techniques for increasing flowering and fruiting, particularly of yellow-poplar. This latter problem is being approached by the Central States Forest Experiment Station through bud grafting and stem grafting techniques. Systemic insecticides to control weevil and other pests offer great hope.

The compartment studies on the Fernow Experimental Forest are somewhat unique in their objective of obtaining roadside costs and returns from five different silvicultural practices. Here they are after long-range answers in silviculture, economics, and forest management. Included also are studies of sites, species reproduction, regeneration of new stands, stand and tree growth studies, and improved log quality and stand improvement.

In watershed management research, the problem of water resource inventory techniques posed by Gil Varney is not being studied except as Bill Sopper and Howard Lull have studied streamflow characteristics on a physiographic regional basis. A good deal more needs to be done along these lines, part of it being a need for synthesizing research results on a watershed, river basin, or regional basis. The problem of reducing excess flows is being attacked through the subsurface stormflow studies by the Central States Station and, in an indirect way, with the cutting treatments applied to both the Coweeta and Fernow Experimental Watersheds. Augmenting low flows is also part of the research which is determining the effects of various cutting treatments on streamflow characteristics at the Fernow and Coweeta, the Coweeta studies of water movement in unsaturated soils, and the studies of soil moisture depletion under different densities of pine plantations in Ohio. As Ed Johnson pointed out and was indicated by both Reigner and Sopper in their presentations, there is considerable study being given to the basic hydrologic processes. It was pointed out several times that results from watershed studies at Coweeta and Fernow might not be repeatable, but the probability remains that if we can learn the basic processes and determine the significant characteristics of watersheds to be managed, we can extend research results to a wide variety of watershed situations.

Strip-mine area rehabilitation research is getting on the move rapidly in Kentucky. Tree planting research on spoil banks has been carried out in West Virginia, Ohio, and Pennsylvania for a number of years. More basic studies of soil chemistry and

hydrology are being started. Design and location of coal haul roads are being studied as well as earth movement, placement of overburden, and revegetation with herbaceous and grass species for quick cover establishment. Other than this, there is very little research in Appalachia on rehabilitation of eroding watersheds as a means of improving water quality.

As to the economics of water, there is no research in the Forest Service but the Economic Research Service, USDA, is set up to do this kind of work. For the most part, the ERS is poorly financed to make economic evaluations of forest watershed management; furthermore, they are more concerned with the economics of water for agriculture. Because water is needed and is used for many purposes, economic studies become extremely complex, difficult, and expensive.

In introducing the subject of the future of forestry research, McLintock, as chairman, pointed out that many changes have taken place in forestry in the last 20 years. Management is now pressing Research for answers to many of its problems and often there is a sense of urgency about it. Those concerned with advancements in forestry must be able to anticipate the needs and the questions that will be asked. In the past, there has been a tendency to leave the anticipation of problems and the asking of questions to the Research group, but this may not always be the best or most complete approach to insure the proper advancement of forestry. Folks engaged in management of the forest resources must also anticipate their problems and ask some of the questions to be solved by Research. For this reason, if for no other, meetings of this kind are good.

In his discussion of the future research program in watershed management at Parsons, West Virginia, Howard Lull gave six points which guide the research program.

1. The research must be useful and answer questions posed by managers of forest resources.

2. The research must develop or determine principles and work out the relationships that prevail between watershed factors.

3. The research must be concerned with the total environment of the watershed.

4. The results of research must be extended beyond the immediate location of the research and into the area or region of principal concern.

5. The research at Parsons must be correlated with research being done at other Stations within Appalachia.

6. The results of research must be published and otherwise disseminated to insure their use by practicing foresters.

Lull indicated that more of the research in the future will be done away from the Fernow Experimental Forest. Emphasis will be given to a regional approach to rain-on-snow flood events, a determination of the potential of Appalachian forests for flood reduction; water quality; and further studies of water yield. The new laboratory will be used for basic studies of soil-plant-water relations.

In timber management research, Warren Doolittle stated that hardwood timber will dominate the research program and that emphasis will be given to timber quality improvement, including cultural treatments as well as individual tree improvement. In the Parsons' research program, studies of silvicultural systems to improve volume and quality of timber will be continued and fundamental research will be carried out to make the research results more universally usable. Short-term studies will be included in the program, but for the most part the long-term silvicultural studies will be dominant. Again, the new laboratory will make possible studies of soils, plant physiology, and other detailed laboratory-type research. Soil-site studies will be continued to determine variation in productivity, and it is anticipated that the soil survey system will be useful in this work. Regeneration studies will be extended in both even and uneven-aged stands, but emphasis will be placed on even-aged management. The principal problem is to reproduce the most valuable species for sustained timber production. In situations where conversion of timber stands is called for, artificial regeneration techniques must be used and these too will be studied.

There is much opportunity for research in tree improvement, particularly in the development of trees for growth, optimum form, disease and insect resistance, and strong characteristics of flowering and fruiting. Studies of weeding, thinning, and pruning will be continued, and it is felt that early release may be important to encourage the best trees within a timber stand. It was pointed out that improvement in growth and quality is closely related to the characteristics of the stand and other environmental factors, and that correlation with other research is important. Attention is being given to costs and returns from the experimental operations, and the Division of Forest Economics will be brought into some of the summary publications of the work to be prepared.

In opening the part of the program dealing with communications, McLintock pointed out that even though Research is being pressed for solutions to practical problems, only a small part of the information available from research is actually being used.

He emphasized that communication is a two-way street and that there must be an exchange of ideas both to and from forest managers and researchers. He also emphasized that there is a greater need for communication within the research organization.

John Hosner stated that communication was the diffusion of ideas and the adoption of ideas and techniques into practice. There are five steps or stages of adoption of ideas as follows: (1) Development of an awareness of a new idea or practice, (2) development of interest in the new idea or practice, (3) evaluation of the new idea or practice, (4) trial of the new idea or practice, and finally (5) adoption of the idea into the going operation. So far as universities are concerned, both faculty and students must go through these stages in the teaching-learning process. The rate of adoption of an idea depends upon its relative advantage; its compatibility with other practices; the complexity of the idea or practice; its divisibility or potential for breakdown into component parts; and its communicability, that is, whether or not it can be demonstrated or made visual. According to Hosner, ideas within universities are not universally adopted until they are included in textbooks. This is recognized as a slow process.

An interesting fact that deserves consideration is that students may learn new ideas in school but they are often never given an opportunity to put the ideas into practice because of the resistance of a supervisor to accept or incorporate a new idea or practice into the job. People in jobs for a long time tend to become fixed in their ideas and do not keep up fully with new developments. For this reason, advanced sabbatical study is important and should be encouraged; where it is not, it sometimes takes a new generation to adopt new ideas which are developed by research or advanced experience.

Mr. Berthy pointed out that in extension work the communication of a new idea or practice results from gradual steps of exposure. Motivation, the media of communication, the providing of alternative courses of action, and patience are all important in communicating new ideas. Also, he says, the new idea must be an integral part of the operation and/or be profitable. In bringing research results and the users of research results closer together, Berthy suggests the following: That wherever possible, applied research be given precedence over basic research; consider means of communication at the time of designing studies; analyze publications for their communications value; review old research results to determine what has gone on before; and include more economics in research programs.

In considering how managers can avail themselves of research results, Supervisor Wentz felt that personal face-to-face communications and close contact between management and research people

was essential, with ideas flowing in both directions. He suggested that a feeling of joint effort be developed and that management people be involved in research projects. He further suggested a step-up of administrative studies, demonstrations, and pilot testing, with close contact and consultation with Research in their establishment and interpretation. In answer to the oft spoken criticism that research results are never complete, it was suggested that the manager should know the direction of the research results and then consult freely with the research worker face to face.

In approaching the responsibility of Research in communications, Weitzman pointed to publications, both technical and popular, show-me trips with on-the-ground discussions of problems and results, training sessions and technical meetings, and discussions of problems and application of results on the manager's home ground. Weitzman pointed out that attitude or the desire to communicate is necessary and that this doesn't always exist among scientists. His admonition to research was (1) that there be a desire to share information, (2)that good communications media be chosen, and (3) that Research produce a good product for management consumption.

An encouraging sign in this meeting was that both Research and Management saw their own responsibilities in improving communications and in getting research results into practice. In no case did anyone point to the failures and weaknesses of the other side as reasons for lack of communication or the slow pace of getting research results into practice.